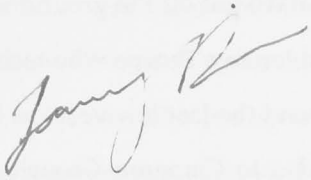
Income, investment and saving

A thesis submitted for the degree of Doctor of Philosophy of the Australian National University, on Friday 18 June 2010, by **Tanuja Doss**, *PhD Candidate, at the Research School of Economics — the Australian National University.*

DECLARATION

The contents of this thesis are original, and the research and presentation were conducted solely by the author, Tanuja Doss.



Signed by Tanuja Doss, Friday 18 June 2010

ACKNOWLEDGEMENTS

So. The signed declaration on the front of this document asserts that the contents of this thesis are original, and that the research and presentation have been conducted solely by me. While that's true as regards the contents of this actual *thesis*, I wouldn't have been in a position to make this original contribution to the literature with my mental health and quality of life (mostly) intact without the support and wisdom of people within ANU, at work, and of course, my long-suffering family and friends.

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As it turns out, submitting a thesis is merely a necessary, rather than a sufficient, condition to graduating, and in this I am grateful beyond words to Bob Breunig for his assistance in jumping the many and varied post-submission administrative hurdles to getting my thesis examined, and addressing the subsequent feedback from the examiners. I also thank the examiners themselves for their thoughtful feedback and suggestions on how to make my work stronger. It would also be appropriate for me to thank everybody who put up with me in the months between the original submission and the examination (you all know who you are) — yes, it is finally safe to ask me about my thesis, now!

And lastly to my parents, Asha and Ram, who have patiently tolerated my non-attendance at family gatherings, my infrequent visits, and my persistent failure to answer the telephone. I think it will have been worth it — I hope they do, too. More than anything else, I am grateful to them for encouraging me in this venture, for helping me stay on track by reminding me why I wanted to do this when I started to lose focus, and for their unfailing love and support.

ABSTRACT

In the last fifty years, the gap in incomes per capita between rich countries and poor countries has widened. There is an evolving literature on the reasons why some countries grow faster than others, while yet other countries appear not to be growing at all. Models of economic growth vary with respect to the determinants of growth and the relative importance of these determinants, however, there is generally a consensus that physical capital is an essential input. Given this, one of the arguments advanced for the growing gap between rich and poor countries is that poor countries are caught in a saving trap — average incomes are too low for saving, meaning that these countries simply cannot afford the investment in physical capital necessary for growth.

This argument immediately raises two questions: firstly how today's rich countries were able to afford the investment in physical capital necessary to grow, when they were once poor themselves; and secondly, how being unable to afford the necessary investment in physical capital can be a meaningful constraint on growth in a world where capital is internationally mobile. If the saving trap were truly a barrier to growth confronting today's poor countries, then the following must be true: a country's rate of saving should increase with the level of income, demonstrating that households will save more if they can afford to; and the rate of investment should be closely linked to the rate of saving, demonstrating that a low rate of investment is due to insufficient saving. Importantly, any increase in saving should be retained as investment.

This thesis finds that while rates of saving rise with incomes in developing countries, this saving is not always retained as investment. This means that low levels of investment in physical capital cannot be attributed solely to lack of affordability due to low incomes and low rates of saving. Borrowing the gravity equation from the international trade literature on intra-industry trade, this thesis develops and tests an alternative model to find that while low incomes and low rates of saving are *a* barrier, they are neither the sole nor the primary barrier to growth.

Further, the application of the alternative model finds that the rate of investment in physical capital across countries is linked to the determinants of the return on that

investment — capital flows out of countries with relatively low marginal products of capital and into countries with relatively high marginal products of capital. Poorer countries not only have less physical capital per capita, but also have disproportionately poorer health, and political and economic institutions compared to developed countries. The ability of physical capital to drive growth in incomes is limited in the absence of a healthy, educated workforce to operate it and generate a return, or the political and economic conditions necessary to ensure that the return that is generated is repaid to investors. As capital markets become more open, developing countries must compete with more developed countries to attract and retain investment.

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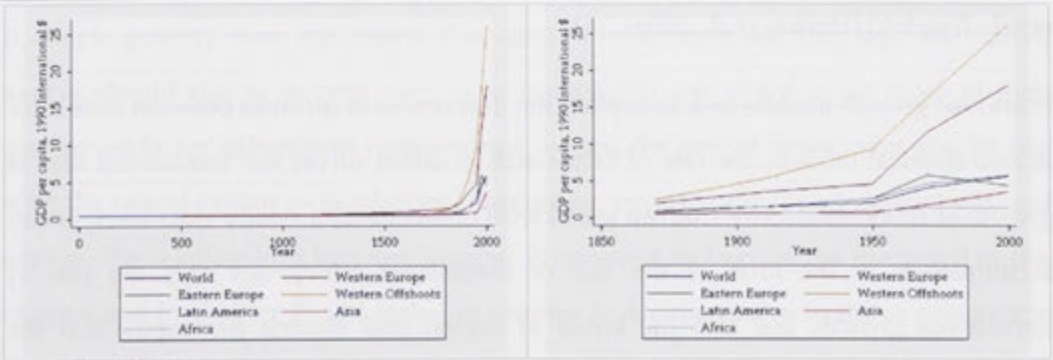
1 OVERVIEW: INCOME AND GROWTH

1.1 INTRODUCTION

On the scale of human history, sustained growth in income per capita is a relatively recent phenomenon. Prior to the nineteenth century, global average income per capita fluctuated at roughly the same level for most of the countries in the world (see Figure 1.1). In his treatise on the determinants of population, Malthus noted that both populations and per capita incomes were constrained by a cycle in which per capita incomes rose with the availability of food, and fell as the population expanded in response to this abundance (Malthus, 1798). He argued that since technology grew at a linear rate, and population unchecked grew at an exponential rate, sustained growth in per capita incomes would never occur. Sadly for Malthus, it was only a few decades after his treatise was published that the rate of growth in technology started to overtake the rate of population growth in what are now 'the developed countries'. The Industrial Revolution of the early nineteenth century, and the associated technological advances, marked the beginning of a steady, sustained upward climb in global income per capita. As Figure 1.1 shows, however, this growth was not equally distributed across countries.

FIGURE 1.1 DIVERGENCE IN GLOBAL INCOMES FOLLOWING THE INDUSTRIAL REVOLUTION



Source: (Maddison, 2001)

Clark (2008) argued that while incomes in the developed countries grew strongly, they actually *declined* in the rest of the world. Maddison (2001) divided the countries of the world into regions, and showed that growth was strongest in the Western European

economies, and their off-shoots (collectively referred to henceforth as 'the western economies').[1] Maddison's data do not show a decline in incomes in the other regions, but it is evident that they did not grow as quickly. In either case, both Maddison's and Clark's data showed that average global incomes were similar across countries for a significant period of time, only to significantly diverge after the Industrial Revolution. The new ideas and knowledge generated in the Industrial Revolution could reasonably be expected to first benefit the western economies in which they originated before they spread through the rest of the world. In the nearly two hundred years since the western economies began their sustained upward climb, however, most of the rest of the world has yet to catch up. More than that: in almost every year, the gap between rich and poor countries has widened further.

For example, in the period that Maddison examined, income per capita in the western economies had risen from around $1,200 in 1820 to $17,000 and $26,000 in western Europe and the western offshoots respectively in 1998 (2001). Meanwhile, average income per capita in Africa was $400 in 1820 and — at $1,300 in 1998 — had grown to roughly where the western economies were nearly two hundred years ago. Using the same dataset, Galor (2005) noted that the ratio of income per capita between the richest and the poorest regions increased from 3:1 in 1820 to nearly 20:1 in 1998. More recently, in the roughly fifty years between 1950 and 2005, income per capita in Ethiopia, the poorest country in 1950, grew by only 50 % in purchasing power parity (PPP) terms, while in Luxembourg, the richest country at the time, income per capita increased nearly five-fold (Heston et al., 2009).

Economic growth models seek to explain the differences in incomes between countries. In neo-classical models, the rate of factor accumulation drives the transitional rate of growth as economies move from an initial level of income to a steady-state level. Factor accumulation in the form of the rate of investment affects not only the rate of transitional growth, but also the levels of capital and income per capita that the economy attains at steady-state. Once the steady-state level is reached, the economy

[1] Maddison defines 'Western offshoots' as Australia, Canada, New Zealand and the United States of America.

grows at a rate of technological progress that is exogenous (Solow, 1956, Swan, 1956). Long run growth is also determined by the rate of technological progress in endogenous growth models. As the rate name suggests, the rate of technological progress in these models is endogenous, and is in turn determined by the rate of human capital accumulation — either as embodied in labour skills, or through expenditure on research and development (Aghion and Howitt, 1998).

In the case of both the neo-classical and the endogenous models, growth in per capita incomes comes at an upfront cost — either through investment in physical or human capital, or both. In the absence of international movement in technology, aid or investment, differences in rates of factor accumulation between countries could be explained by poor countries being unable to afford to become any richer. Incomes are low, as a result of which rates of investment in physical and human capital are also low. Since either or both of these are the major drivers of economic growth, the rate of growth is low, and so a poor country remains mired in poverty. A pessimistic take on this would imply that today's poor countries are consigned to poverty forever. Poverty by itself being a barrier to growth in incomes is an unsatisfactory explanation, since it fails to explain how today's rich countries managed to grow. At some point in their development history, today's rich countries were able to overcome poverty. The widening gap in incomes per capita suggests that today's poor countries are either unable to overcome poverty in the same way, or they are faced with different barriers to growth.

If simple poverty were the reason that rates of investment are low, then the rate of saving should rise as income rises — as households can afford to set more of their income aside for subsequent consumption — and the rate of investment should rise with the rate of saving — as additional saving is converted into much needed physical capital. The relationships between income, investment and saving are discussed in this chapter and in chapter 2, and tested in chapter 3. An alternative to the simple saving trap described is that today's poor countries are unable to accumulate sufficient physical or human capital because they must compete with today's rich countries to attract and retain investment — a barrier that today's rich countries were not confronted with when they were poor themselves. As long as capital markets are open

and unhindered, capital should flow to where it can generate the highest return. Poor countries are disproportionately afflicted by poor health, poor nutrition, poor institutional quality, civil wars and lower educational attainment than rich countries — all factors that affect the incentive to invest in physical and human capital in these countries, and the associated return. Chapter 4 incorporates these variables into an alternative model, which is tested in Chapter 5.

This chapter is divided into four sections. The first discusses the role of the rate of investment, among other variables, in driving economic growth. The second section is a discussion of barriers to growth — in particular, the simple saving trap that this thesis will test. The third summarises the existing empirical literature about the extent to which poverty is itself a barrier to growth and the fourth concludes.

1.2 WHAT DRIVES ECONOMIC GROWTH?

In a closed economy — or in an open economy where the current and capital accounts are balanced and the terms of trade are constant — domestic income is equal to production, which is equal to expenditure. Growth in incomes, therefore, is the same as growth in output. In the Solow-Swan neo-classical growth model, output (Y) is defined as an increasing function of capital (K), and effective labour (AL). Effective labour is the product of labour (L) and labour augmenting technology (A). The neo-classical model is assumed to exhibit constant returns to scale, and positive but diminishing marginal returns to individual inputs. Further, each input is essential —there is no output if one of capital or effective labour is missing. Finally, in order for there to be a single, stable, non-trivial steady-state, the production function is assumed to meet the Inada conditions.[2] The Cobb-Douglas production function with constant returns to scale meets all of these requirements, where output is defined as:

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[2] The Inada conditions require that for any $y = f(x)$:

- $f(x)$ is continuously differentiable and strictly increasing in x;
- $f(0)=0$;
- $f'(x)$ is decreasing in x;
- $f'(0)=\infty$; and
- $f'(\infty) = 0$ (Inada, 1963).

(1.1) $$Y = K^{\alpha}\left(AL\right)^{(1-\alpha)}$$

By assumption, α is constant, and $0 < \alpha < 1$. To analyse incomes per effective worker, the production function is re-specified in intensive form, to give:

(1.2) $$y = k^{\alpha}$$

where y is income per effective worker, and k is the ratio of capital to effective labour ratio.

The rates of growth for labour and for technology are exogenous, fixed, and defined as:

(1.3) $$L(t) = L(0)\bullet e^{nt}$$

and

(1.4) $$A(t) = A(0)\bullet e^{gt}$$

The rate of growth for capital is endogenously determined within the model. The stock of capital in a given period is equal to the stock of capital in the preceding period plus any gross additions or upgrades (investment), less any stock that is broken down or redundant (depreciation). In this closed economy Solow-Swan model, investment is equal to saving, where saving is some fixed and exogenous proportion ($0 < s < 1$) of income. The rate of depreciation is also exogenous and fixed, and denoted as δ ($0 < \delta < 1$). The stock of capital per effective worker is also effectively depreciated by growth in the population and in technology. The equation of motion for the country's capital stock per effective worker is therefore:

(1.5) $$\dot{k} = s\bullet k^{\alpha} - \left(n + g + \delta\right)k$$

From this, the proportional growth rate of capital per effective worker is:

(1.6) $$\hat{k} = \frac{\dot{k}}{k} = \frac{s}{k^{1-\alpha}} - \left(n + g + \delta\right)$$

Finally, the proportional rate of growth of income per effective worker is:

$$\hat{y} = \frac{\dot{y}}{f(k)}$$

$$= f'(k) \bullet \frac{\dot{k}}{f(k)} \tag{1.7}$$

$$= \alpha \left[\frac{s}{k^{1-\alpha}} - (n + g + \delta) \right]$$

The proportional growth rates of income and capital per capita decline with respect to capital per effective worker — the more capital per capita a country has, the slower its transitional rate of growth, which is consistent with the model's diminishing marginal returns to individual inputs. The transitional growth rate is exhausted once the economy reaches steady-state, which is the level of capital per effective worker at which additions to the capital stock are exactly off-set by removals from it, or:

$$s \bullet \bar{k}^{\alpha} - (n + g + \delta)\bar{k} = 0$$

$$\bar{k} = \left[\frac{s}{(n + g + \delta)} \right]^{\frac{1}{(1-\alpha)}} \tag{1.8}$$

The steady-state value of capital per effective worker can be substituted into the production function to give the steady-state value of income per effective worker:

$$\bar{y} = \left[\frac{s}{(n + g + \delta)} \right]^{\frac{\alpha}{(1-\alpha)}} \tag{1.9}$$

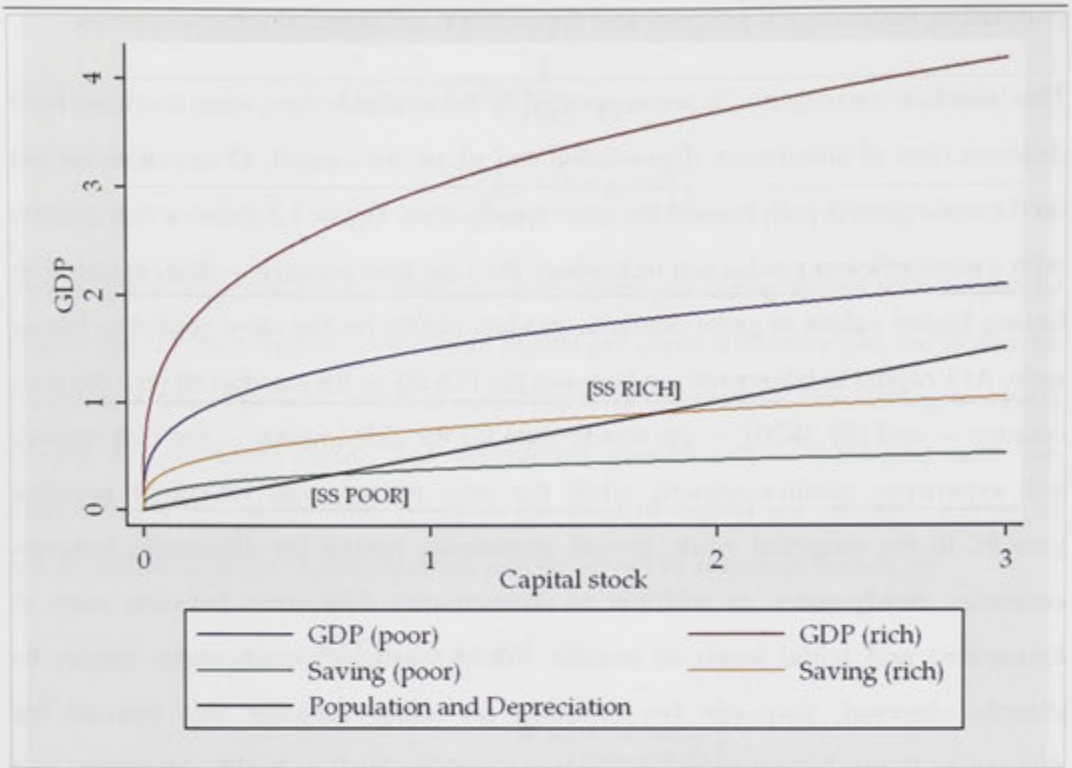
The neo-classical model implies that differences in transitional growth rates between countries can be explained by the current capital to effective labour ratio relative to its steady-state level $\left(k/\bar{k}\right)$, the rate of saving (s), and the rates of population growth (n), depreciation (δ) and knowledge and technology (g). Differences in these variables across countries mean that not only do countries have different transitional rates of growth, but that they are also converging towards different steady-state levels of income and capital per capita. By assumption, the rate of investment is the only variable in the neo-classical model that can be directly affected or chosen by households — the others are either taken as given (n, g, δ) or are the result of changes in other variables (k). As described, the model predicts that during this transition, rich

countries will grow more slowly than poor countries — as long as rates of investment, population, technological progress and depreciation are identical across countries.

This 'absolute convergence' is not supported by the available data, since countries have different rates of investment, depreciation and so on. As a result, all countries are not on the same growth path toward the same steady-state. Figure 1.2 shows a rich country with a more efficient production technology than the poor country — demonstrated by having higher values of gross domestic product (GDP) for the same capital to labour ratio. At a capital to labour ratio in between [SS POOR] — the steady-state for the poor country — and [SS RICH] — the steady-state for the rich country — the rich country will experience positive growth, while the poor country will encounter negative growth. In the empirical work, growth economists control for differences between countries' steady-states, in addition to cross-country differences between rates of investment and initial levels of income. While countries' steady-states cannot be directly observed, they can be controlled for using variables that account for differences in production technology across countries, such as health, education, and institutional quality. Differences in countries' rates of growth can then be explained by differences in countries' distances from their steady-states.

The long run rate of growth is evaluated once the transition is complete, and the economy has reached steady-state. Since the steady-state is defined as the point at which there is no net capital accumulation per effective worker, the long run rate of growth in income per capita (as opposed to per effective worker) at steady-state is the rate of growth of technological progress, g. With no sustainable gain from simply increasing capital or labour, the only way to increase output (and through it, income) per capita is to improve the production technology in order to generate more output with the same amount of input — similar to the western economies' escape from Malthus' population trap. As long as the speed of convergence is not instantaneous, then the exogenous growth of technology can transform the economy's steady-state into a moving target. This means that the rate of growth for the economy is a combination of the transitional growth rate, and the rate of growth of technological progress.

FIGURE 1.2 ALLOWING DIFFERENT STEADY-STATES FOR DIFFERENT COUNTRIES



Many economists have argued that simply taking the rate of technological progress as exogenous is unsatisfying, given the implications for country's rates of growth — particularly since it fails to explain the divergence in countries incomes. Treating the rate of technological progress as exogenous implies that no action can be taken to affect the long run rate of growth. Endogenous growth theories sought to fill this gap in the literature, through the development of models of growth in which the rate of technological progress was determined within the model's framework. There is a rich and continually evolving literature on whether neo-classical or endogenous growth models best fit the data. While there is evidence to support endogenous growth models, and the models themselves have evolved to better fit the data, the focus of this thesis is on the saving trap and the neo-classical model's prediction that capital should flow from rich to poor countries because there are diminishing marginal returns to capital. For this reason, endogenous growth models are not discussed further.

1.3 BARRIERS TO GROWTH

Physical capital is essential to economic growth. Equally important, however, are the variables that determine the economy's steady-state, or long run growth rate — physical capital is nothing without healthy, skilled, labour to operate it, and an institutional infrastructure that facilitates the production of output and the payment of returns. The empirical support for conditional convergence depends on the effect that variables such as health, education, and institutional quality have in controlling for differences in production technologies across countries. This explains how, in spite of diminishing marginal returns to capital, a capital-rich country with a higher rate of investment or a superior production technology can have a higher marginal product of capital than a capital-poor country. Where a country's low rate of investment, or inferior production technology, is due to poverty, the country's poverty can become a barrier to growth.

In the same year in which Solow and Swan developed their now familiar growth model, Nelson (1956) developed a growth model that allowed for more than one steady-state, the lowest of which was a poverty trap, or a 'low-level equilibrium', using the same Cobb-Douglas production function shown in equation (1.1). Income per capita grows when the proportional rate of growth of income is higher than the proportional rate of growth of the population — in line with Malthus' population trap. Nelson generated multiple equilibria by allowing the model's dynamics to vary according to whether average incomes were lower than or equal to subsistence levels, or whether they were higher. An economy was likely to be trapped at the low-level equilibrium if: the rate of income growth was close to the rate of population growth; the marginal propensity to invest out of income was low; there was a shortage of uncultivated but arable land; and the production technology was inefficient (Nelson, 1956, p. 901).

Nelson went on to argue that an escape from the low-level equilibrium would be achieved through some combination of: raising the rate of investment; increasing labour force participation; initiating a government investment program; utilising a more efficient production technology; and changing the social structure (encouraging

smaller families, thrift and entrepreneurship). Nelson noted that inflows of aid or investment from abroad could potentially free a country from the trap if they were accompanied by socio-political changes or they were large enough to permanently move the economy away from the low-level equilibrium, and to a level of income at which the domestic rate of saving increases, and a higher stable equilibrium can be sustained. It is this last that forms the basis of the 'big push' theories of Rosenstein-Rodan (1943) and Murphy et. al. (1989). There is, however, evidence that such an approach may not meet with success in the absence of other initiatives — in particular, initiatives that address institutional quality (Easterly, 2005).

Attempting to establish whether poverty is a barrier to a country's economic growth is difficult, because it requires an answer to the following question: what would be different if the country were not poor? Simple poverty is not enough to designate a country as being caught in a poverty trap, since a country may be relatively poor, but growing rapidly as it moves from its initial level of income towards its steady-state. A low, zero or negative growth rate by itself is also not enough, since neo-classical theory predicts countries' rates of growth will slow as they converge on their steady-states. Low incomes and a low or negative rate of growth are necessary but not sufficient conditions to determine whether or not a country is caught in a poverty trap. The 'sufficient' condition is that increasing income or capital per capita leads to an acceleration in the country's rate of growth, and that this movement toward a higher steady-state level of income and capital per capita can be sustained once foreign aid or foreign capital is no longer forthcoming. Related to this is the fact that a country with an economy characterised by a neo-classical model can temporarily enjoy income per capita higher than the steady-state level — it is only that this higher level of income cannot be sustained in the absence of continued inflows of foreign capital or aid.

Establishing this counterfactual, 'what would be different if the country were rich' scenario is complicated further by the fact that poverty is not the only type of barrier to growth, and poor countries are often afflicted by more than one such type. These other barriers — such as poor health, education, institutional quality and so on — will erode the expected return on investment, and therefore reduce the willingness of households that are otherwise able to invest in that country. In seeking to explore why capital does

not flow from rich countries to poor countries, Lucas (1990) suggested that once differences between poor and rich countries in variables such as human capital accumulation, political risk, or institutional quality had been accounted for, the marginal product of capital in poor countries was not necessarily greater than in rich countries. Under these circumstances, an inflow of foreign capital or aid will not, by itself, lift the country out of poverty permanently. Inflows of foreign aid and capital in the absence of reforms to health, education, institutional quality, and so on, may do more harm than good. There is evidence to suggest that improperly allocated foreign aid can have adverse long-term effects on a country's growth prospects, partly due to countries becoming dependent on aid, and partly due to concerns about the aid being misappropriated (Burnside and Dollar, 2000, Easterly, 1999).

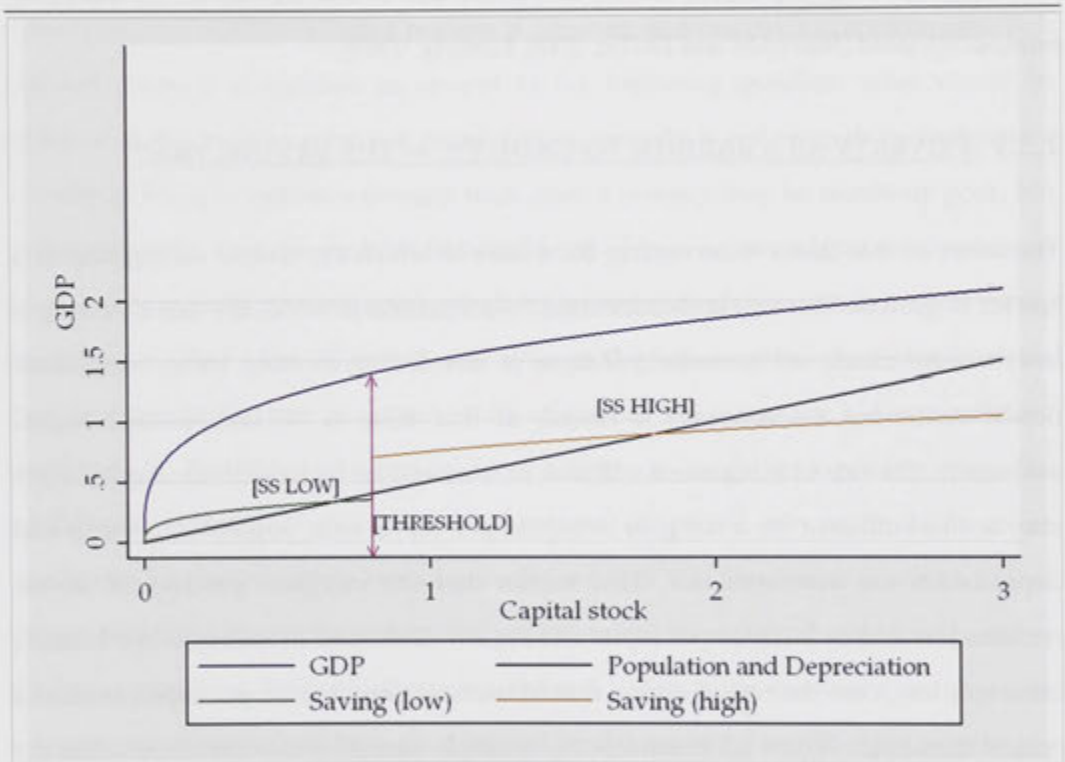
1.3.1 POVERTY AS A BARRIER TO GROWTH — THE SAVING TRAP

The focus of this thesis is on testing the extent to which the simple saving trap is a barrier to growth. The trap is characterised by a situation in which the rate of saving is low because nearly all household income is devoted to meeting basic, subsistence needs. Assuming the economy is closed, or that there is no international capital movement, the rate of investment will also be low, and an increase in the capital stock may not be sufficient for a net gain in capital per capita once population growth and depreciation are accounted for. This means that the marginal product of labour remains low and so incomes per capita remain low. If the rate of saving is low because income is low, then the rate of saving should increase once income per capita reaches a critical threshold. Figure 1.3 illustrates the multiple equilibria that can arise when the rate of saving is non-constant with respect to income.

In Figure 1.2 earlier, two different steady states were shown for two different countries with two different rates of saving for all levels of income. Figure 1.3 is different, because it shows two different rates of saving for the same country, varying according to that country's level of income per capita. At low levels of income and capital, the rate of saving is low, and the level of saving is indicated by ***saving (low)*** in the figure. Once income per capita increases beyond a given threshold — shown as [THRESHOLD] in Figure 1.3 — households can afford a higher rate of saving, shown

as ***saving (high)***. Countries that start with an initial level of income that is less than the threshold level will converge on low levels of income and capital per capita [SS LOW]. Countries with an initial level of income that is greater than the threshold will converge on the higher levels of income and capital per capita, associated with the point labelled [SS HIGH] in Figure 1.3. In a closed economy, and in the absence of a windfall income gain, there is no way for a country that is converging toward [SS LOW] to ever reach [SS HIGH] unless, for some reason, the rate of investment is increased.

FIGURE 1.3 THE SAVING TRAP — MULTIPLE EQUILIBRIA



There are a number of intuitively appealing explanations for why the rate of saving may vary with the level of income. From the neo-classical model, households in a closed economy cannot consume all of their income and save nothing, since capital is an essential input into the production function. In practice, households also cannot save everything and consume nothing, as they will not survive from one period to the next. The choice of the rate of saving must fall somewhere between these two extremes, but there is nothing in the Solow-Swan model to specify how (Barro and Sala-i-Martin,

2004) the rate of saving should be chosen.[4] The Ramsey-Cass-Koopmans model, an extension of the Solow-Swan model (which is discussed further in the next chapter), dynamically optimises the rate of saving by introducing parameters that control for households' rates of time preference and inter-temporal substitution, and the rate of return on capital. The relationship between income and the rate of saving as predicted by the Ramsey-Cass-Koopmans model can be ambiguous. It is generally expected to increase with income when households want to smooth consumption over time, which means that rates of consumption are higher at low levels of income. In a closed economy, this effect can be offset by the diminishing marginal return on capital associated with higher levels of capital per capita, and the fact that as household income increases, the return on investment is lower. Empirically, Barro and Sala-i-Martin note that the rate of saving tends to rise with income when an economy is in transition towards its steady-state (2004).

The parameters of the Ramsey-Cass-Koopmans model may be such that households at low incomes consume almost nothing, and save almost everything — after all, it is possible that rates of return may be high enough, and that households are patient enough and flexible enough with respect to when they enjoy their consumption. Assuming, as Nelson (1956) did, that a minimum level of consumption is required in each period in order for members of the household to subsist, there is a limit to the extent to which consumption can be delayed. While there is no consensus on what this minimum amount is, or what it should cover — let alone how to allow for differences in preferences across individual households and even countries — the idea of there being a minimum level of consumption is a relatively uncontroversial one. One benchmark is the World Bank's definition of 'absolute poverty', which is $1 a day in PPP terms. It was estimated that in 27 countries around the world, more than a quarter of the population lives on less than $1 a day (UNDP, 2003), indicating that there are households that are unable to meet even the most basic needs out of their income.

[4] There is a 'golden rule of capital accumulation', which is defined as the point at which the level of consumption is equal to the level of saving, and under which households do not consume any more than they set aside for future generations (Barro and Sala-i-Martin, 2004). In the absence of intertemporal substitution elasticities, or rates of time preference, there is nothing inherently superior about the golden rule condition.

From this, it is reasonable to suggest that households on low incomes may increase rates of saving as their incomes overtake the subsistence threshold.

Essentially, there are four reasons why the rate of saving may be low at low incomes. The first is that if households do not fully consume their incomes, they risk starvation. Gersovitz (1983) explicitly modelled the probability of a young agent surviving to old age as a function of that agent's consumption when young. Forgone consumption in the current period reduces the probability of the agent surviving until the next period. An agent who does not eat today in order to save may not live to enjoy the return on their investment. The second reason is that insufficient consumption may reduce the agent's physiological capacity for work. This follows from the Shapiro-Stiglitz (1984), efficiency wage argument — foreign owned firms in developing countries offer a wage that is higher than the market clearing rate in order to attract workers, but also to ensure that they are well-nourished because well-nourished workers are more productive, and miss fewer days due to illness. Another aspect of this same issue is that parents who are undernourished are more likely to have children that are also undernourished. This occurs not only because the parents' incomes are insufficient to provide for the children, but also because the child is born with a lower birth weight, which has implications for its subsequent health and development (Dasgupta, 1997).

Thirdly, even after they have reached the level of subsistence, households at low incomes are likely to be less patient with respect to the inter-temporal substitution of consumption. Life expectancy is lower in poorer countries than in rich countries, but may not necessarily be endogenous as in Gersovitz's model. Even if increased consumption has no meaningful impact on longevity, agents with a lower life expectancy will discount delayed consumption at a much higher rate than agents with a longer life expectancy — simply because the likelihood of their surviving to derive utility from the delayed consumption is so much less — which is reflected as greater impatience. Controlling for differences in age, education, family size and race, Lawrance estimated that on average, the rate of time preference for low income households was three to five percentage points lower than for richer households, for a panel sample of households in the USA between 1974 and 1982 (1991, p. 55). Lawrance noted that a higher rate of time preference in low income households led not only to a

lower rate of saving, but also to reduced investment in education. At a cross-country level, Chakraborty extended Gersovitz's model of endogenous longevity to take account of investment in human as well as physical capital, and found that low rates of investment in both types of capital are associated with countries where life expectancy is low (2004).

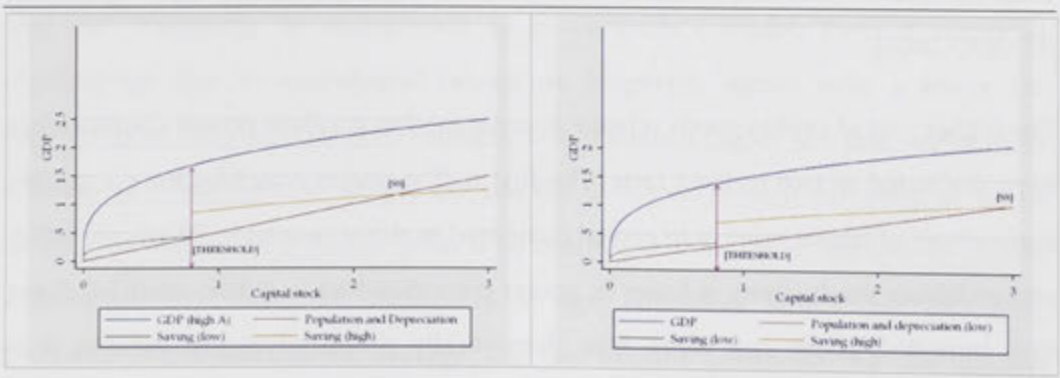
This aspect of the low income saving trap may be further exacerbated by the fourth and final reason, which is the fact that the price of capital goods relative to consumption goods is higher in poor countries than it is in rich countries. Households in poor countries may appear to be more impatient because they have to give up a greater volume of consumption goods — including the basics, such as food, shelter, clothing and so on — to purchase the same volume of capital as households in rich countries. The prices of capital goods in poor countries are usually also higher in absolute terms compared to rich countries due to the transport costs and tariffs that are added at import. For example, the cost of items of capital equipment items in Egypt, Iran, Kenya, Morocco, Nigeria and Zimbabwe was estimated to be around three and a half times as expensive as in the countries where they were manufactured (Eaton and Kortum, 2001). Capital goods are imported by poor countries, since more than 70 % of the world's production of capital goods occurs in developed countries (UNIDO, 2005). In 2003, developed economies accounted for 91 % of the world's manufacturing value added in office, accounting and computing machinery, 89 % of electrical machinery and apparatus, 73 % of radio, television and communication equipment, 85 % of motor vehicles, trailers and semi-trailers, and 84 % of other machinery and equipment (UNIDO, 2005).

The higher cost of capital goods relative to consumption goods in poorer countries has been attributed to two stylised facts. The first is that poorer countries have a greater endowment of labour relative to capital compared to richer countries (Bhagwati, 1984), and so labour productivity is lower in poorer countries than in richer countries. From this, imported goods cost more than domestically produced goods, because it is assumed that the price of traded (capital) goods is linked to international prices while the price of non-traded (consumption) goods is linked to the low wages associated with low productivity (Kravis et al., 1982). Both of these things put together mean that

the higher relative price of capital goods in poor countries compared to rich countries occurs *because* poor countries have less capital per capita. Put together with the likelihood that households on very low incomes cannot afford to defer much consumption to begin with, the rate of saving at low incomes falls even further.

The obvious way out of the saving trap is to increase the rate of saving at lower levels of income so that the model only allows for a unique steady-state, rather than the multiple equilibria shown in Figure 1.3. As noted by Nelson (1956), depending on the parameters of the model, an alternative solution may be to improve the production technology used, so that for the same rates of saving at low and high incomes, only a single steady-state exists (as indicated by 'GDP (high A)' in Figure 1.4), because more output is produced with the same amount of capital. Another option, which is also shown in Figure 1.4, is to slow the rate of population growth (indicated by 'population and depreciation (low)'). At low levels of income, however, it may not be any easier to improve the production technology or slow the rate of population growth than it is to arbitrarily raise the rate of saving. Undertaking these sorts of changes requires investment in health and education, initiatives to address the higher relative price of capital goods — such as better transport infrastructure or lower tariffs — and so on, in order to ensure the goal is met in the longer term. All of these things come at a cost, which may seem just as insurmountable to low income countries as delaying consumption at low incomes.

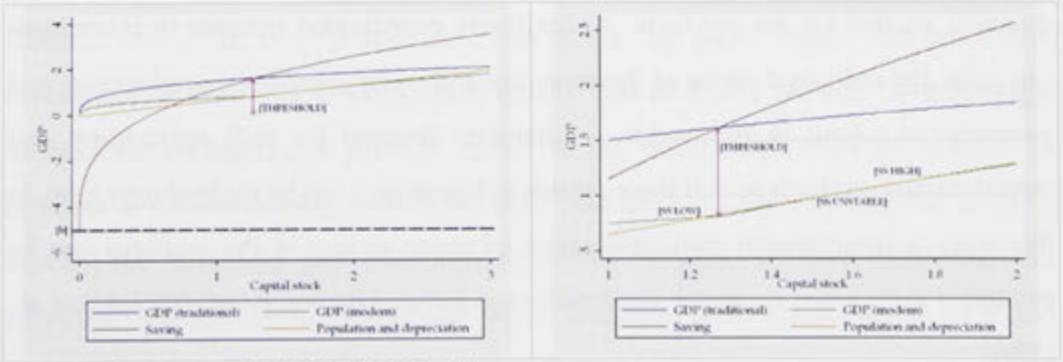
FIGURE 1.4 THE SAVING TRAP — UNIQUE EQUILIBRIUM



1.3.2 OTHER BARRIERS TO GROWTH

The saving trap is only one type of barrier to growth. The rate of saving is the only variable in the Solow-Swan model that can be directly chosen, even if it is not optimised as in the Ramsey-Cass-Koopmans model. This does not mean that the other variables in the model can or do not vary at different levels of income. Another way in which multiple equilibria can arise is if the relationship between capital and output — the production technology itself — is more efficient at a higher level of capital per capita than at low levels. This violates the Inada conditions, since it means that there is a range of capital per capita across which there are increasing marginal returns to capital. The 'big push' literature in economic growth relies on the existence of these increasing returns. At low incomes, countries generate output using a 'traditional' technology —for example, an agrarian production technology. A more efficient use of the same capital would be to adopt a modern production technology — such as manufacturing — but this can only be done at a fixed cost per worker, as shown in Figure 1.5. Increasing marginal returns to capital per capita occur close to the point at which it is economical for the economy to switch to the modern technology (shown as [THRESHOLD] in Figure 1.5). At [THRESHOLD], both production technologies produce the same amount of output per capita from the same amount of capital per capita (net of the fixed cost of the modern technology).

FIGURE 1.5 INCREASING RETURNS TO SCALE — MULTIPLE EQUILIBRIA



Source: Based on (Barro and Sala-i-Martin, 2004, p. 75)

In addition to [THRESHOLD], there are three other points of interest in this model's dynamics — the low-level equilibrium [SS LOW], the unstable steady-state [SS UNSTABLE], and the high level equilibrium [SS HIGH]. Countries that have

capital per capita that is lower than the level at [SS UNSTABLE] will converge on the low-level equilibrium at [SS LOW]. This is because the rate at which the stock of capital is depleted through depreciation and population growth is greater than the rate at which it is accumulated. Countries that have a starting value of capital per capita that is higher than the level at [SS UNSTABLE] will converge on the high level equilibrium at [SS HIGH]. As the dynamics are shown in Figure 1.5, it is possible for a country to adopt the modern production technology, but unless its big push toward development moves it to a level of capital per capita that is greater than [SS UNSTABLE], it will eventually return to [SS LOW]. A second, related point is that the model dynamics allow for two countries to have levels of capital per capita that are similar in magnitude to one another, but that are on either side of the level of capital per capita at [SS UNSTABLE]. From these initial starting points that are so close to one another, levels of capital and income in these two countries will diverge from one another as they move towards different steady-states.

Much of the 'big push' literature is based on the work of Rosenstein-Rodan, in which some level of coordination is necessary in order for the economy to exploit the increasing returns present in the model. In Rosenstein-Rodan's model (1943), increasing returns to scale arise when domestic demand for goods from the modern sector is insufficient to sustain a profitable, modern sector in that country. Domestic demand for manufactured goods is low *because* the country is poor, and average incomes are low. The incentive to invest in the modern sector is limited by the domestic market for the products. A significant, coordinated increase in investment can grow the industrial sector of the economy and — by increasing employment and payments to labour in this sector — stimulate demand for both agricultural and manufactured products so that these returns to investment can be realised over time. In this way, 'a simultaneous industrialization of many sectors of the economy can be profitable even when no sector can break even industrializing alone' (Murphy et al., 1989).

There are other types of coordination failure that can be addressed by a big push. For example, capital goods may not be divisible into increments that each pay a return — an investment in two metres of railroad will not generate a higher proportional return

than an investment in several hundred kilometres of railroad. Secondly, a railroad connecting an inland mine to a port on the coast may not be built at all unless the mine is operational, and the mine may not be profitably operated unless there is a reliable way to transport the output to the port. Under these circumstances, it is the role of government to identify and address such bottlenecks through public investment. A government's budget depends on what it can raise through taxation, and if output and income are low, then tax receipts are also necessarily low. This also makes it difficult for governments to borrow from the rest of the world. Thirdly, the coordination failure may not be limited to where there are increasing returns with respect to physical capital alone, but to the broader definition of capital, which includes human capital such as health and education.

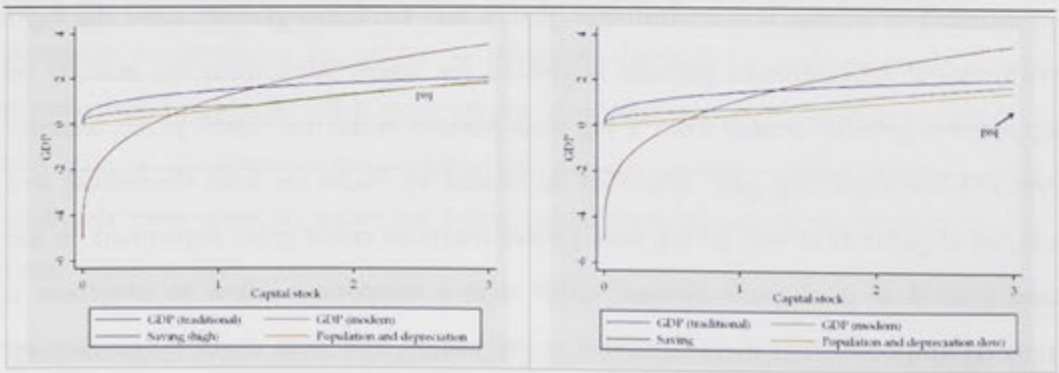
The 'big push' is an argument that Sachs makes. It is implied in the Millennium Development Goals, which seek to end poverty by 2015 by improving outcomes in health, education, and fertility as well as incomes. In this case, it is the necessary investments in education and health that form the fixed cost b shown in Figure 1.5. Once that cost is met, Sachs argues that '[a]ll good things tend to move together...: capital stock, greater specialisation, more advanced technology, and lower fertility... Economic development...tends to build on itself. But it must get started' (2005, p. 73). Sachs further estimates the cost of 'getting started', and uses the Harrod-Domar financing gap model (Domar, 1946) to put a value on the shortfall that must be met by foreign aid.

Easterly, one of the most prominent critics of the 'big push', argues that more than investment or saving, it is institutional quality that facilitates growth, since the right institutional arrangements provide incentives for 'small steps from the bottom' as opposed to growth coming from 'a big push planner at the top' (2005, p. 30). Easterly rejected the 'financing gap' approach advocated by Sachs on both theoretical and empirical grounds (1999), noting that: poorer countries could grow dependent on aid and treat it as permanent income, rather than a temporary inflow to overcome a poverty trap; and that there existed a moral hazard risk with countries consuming foreign aid — instead of saving or investing it — in order to widen the financing gap to attract yet more foreign aid. Finally, Easterly pointed to the mammoth task of

information gathering and consolidation necessary to plan, implement and evaluate the success of a big push, and noted that there are no easy answers as to how the process would be managed. By the same token, however, Easterly only advocated that poor countries improve institutional arrangements through the adoption of 'democratic institutions and economic freedoms', and — since he treats institutions as exogenous — provided no insight as to how a positive change in institutional quality may actually be effected and sustained. By contrast, Glaeser et. al., for example, linked institutional quality to education, and argue that increased education leads to people participating more in the political process, and that effectively, countries need to be able to afford good institutions, which implies yet another type of barrier to growth (2007).

As with any growth model characterised by multiple equilibria, there is more than one way for a country caught at the low-level equilibrium to escape. The 'big push' is one such approach to the model with increasing returns shown in Figure 1.5. As with the saving trap, one of the ways in which the trap can be escaped is to alter the rate of saving, or the rate of population growth, so that there is only a single equilibrium as shown in Figure 1.6. Depending on the model parameters, it may be possible to eliminate all but the highest steady-state by selecting a sufficiently high rate of saving, or implementing policies that inhibit the rate of population growth, as shown in Figure 1.6. The extent to which the country can do so, of course, depends on what its households can afford.

FIGURE 1.6 INCREASING RETURNS TO SCALE — UNIQUE EQUILIBRIUM



1.4 EVIDENCE

Empirical tests show that the neo-classical model provides a good fit for the data, in spite of the gap between rich countries and poor countries being wider in 2005 than it was in 1955 (see Table 1.1 and Figure 1.7). The failure of poor countries to catch up is at odds with the neo-classical model's predictions, however, this can be reconciled since the model only predicts that poor countries will grow faster than rich countries if everything else is equal. Since countries vary with respect to their rates of saving, education, health, production technologies, rates of population growth, and institutional arrangements, everything else is demonstrably not equal. When these differences are controlled for, the transitional rate of growth depends on how far away a country is from its unique steady-state levels of income and capital per capita, and there is evidence to support this 'conditional convergence', where a country's steady-state level of income is conditioned on some combination of rates of investment and population growth, and the variables such as education, health and institutional quality that determine the country's production technology.

TABLE 1.1 GDP PER CAPITA — SUMMARY FIGURES

	n	*Min*	*Max*	*St. Dev.*
1955	71	$406	$15,246	$3,812
2005	71	$366	$71,209	$14,285

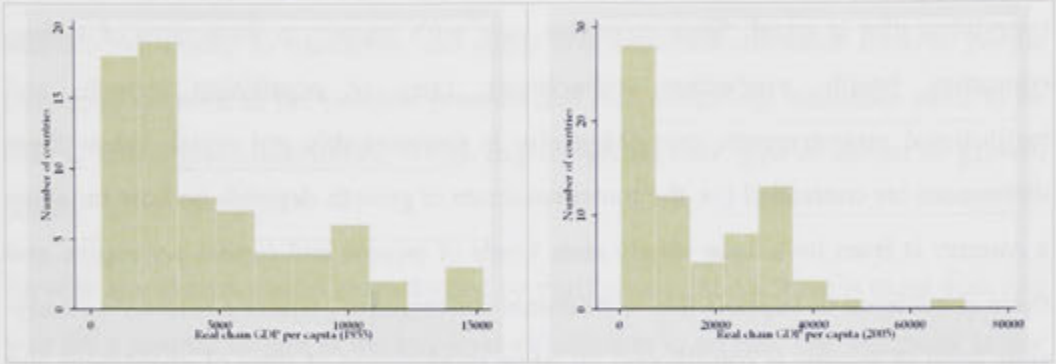
Source: (Heston et al., 2009)

Empirical work in this area has focussed on establishing which cross-country differences have the greatest impact on a country's steady-state goal, as well as how to identify these variables and test their validity. The influential work of Sachs and Warner (1997) advanced the importance of controlling for cross-country differences in economic openness, population growth, government spending, institutional quality, life expectancy, geography,[5] and the share of GDP made up of exports of natural resources. In their discussion on the empirics of economic growth, Barro and Sala-i-Martin (2004) suggest that a 'basic' cross-country growth regression would include controls for: the investment ratio and the log of initial income; measures of

[5] 'Favourable' geography is where a country is not situated in the tropics, and/or not landlocked

economic stability such as government spending, openness, the terms of trade and the rate of inflation; population dynamics such as fertility and life expectancy; human capital accumulation, such as enrolment ratios or average education attainment; and measures of political stability, such as the rule of law, democracy, and whether or not there have been any civil wars or political assassinations.

FIGURE 1.7 HISTOGRAMS OF GDP PER CAPITA — SELECTED COUNTRIES



Source: (Heston et al., 2009)
Note: There are seventy-one countries in the sample for both 1955 and 2005.

All of these variables have tested well in the empirical literature. The work of Acemoglu et. al. (2001) and Rodrik et. al. (2004), for example, established the importance of differences in institutional quality[6] across countries as accounting for much of the cross-country differences in levels of income. Bhattacharyya (2004) undertook the same analysis as Rodrik et. al. but with economic growth, rather than levels of income, as the dependent variable, and established that cross-country differences in institutional quality also explained cross-country differences in rates of growth. With respect to human capital, Mankiw et. al. (1992) undertook an extension of the Solow-Swan model to include it as a complementary input to physical capital, and this work was built upon by Dowrick and Rogers (2002), in demonstrating that cross-country differences in human capital accumulation explained the different speeds at which countries could absorb technology, and subsequently, their different rates of economic growth. In addition to this, human capital accumulation has also been linked to reducing the rate of fertility (Galor and Weil, 2000), and as being one of the variables

[6] Institutional quality in each study was reflected in cross-country differences in the average protection against appropriation risk, and the rule of law respectively.

that positively influences institutional quality (Glaeser et al., 2007). As discussed already, the average level of health in a country — both in terms of mortality and morbidity — is an important consideration, as demonstrated in Chakraborty's (2004) work on the impact of health and mortality on saving decisions and the implications for poverty traps. Gallup and Sachs (2001) specifically focused on the impact of malaria on the economic prospects of countries, and found that countries where malaria was prevalent had significantly lower growth than countries with less 'intensive' malaria, after controlling for cross-country differences in initial incomes, geographic location, institutional quality and economic openness. More recently, Weil (2007) estimated that if there were no cross-country differences in health, then the variation in the log of GDP per capita across countries would also be significantly reduced.

As well as identifying and testing individual variables — with appropriate controls — there is also a considerable literature on testing the robustness of these variables, including how well they perform if there are changes made to the other variables that are included in the specification. For example, Martina (2009) examined the rapid growth of some of the East Asian economies, and found that while health and institutional quality were linked with sustained growth in incomes, it was not possible for a country to sustain growth with one and not the other. Glaeser et. al. looked at the role of human capital and education in economic development, and compared the histories of North and South Korea after their separation. Both North and South Korea were dictatorships initially, but South Korea eventually moved to a model of democracy because South Korea had higher economic growth, and higher human capital attainment. The authors argue that it was is factors that influence institutional quality (2004). In the 1990s, it was found that investment in machinery and equipment, which embodies technological development, was critical to the growth prospects of developing countries (De Long and Summers, 1993). The impact of equipment investment on economic growth remained positive and significant irrespective of which other variables were controlled for — a result which has been arrived at by more than one study (Levine and Renelt, 1992; Sala-i-Martin, 1997). This is of particular importance because empirical results of models of economic growth are highly sensitive in relation to the specification of the model, and which variables are included in the regression. More recently, Sala-i-Martin et. al. undertook a similar analysis

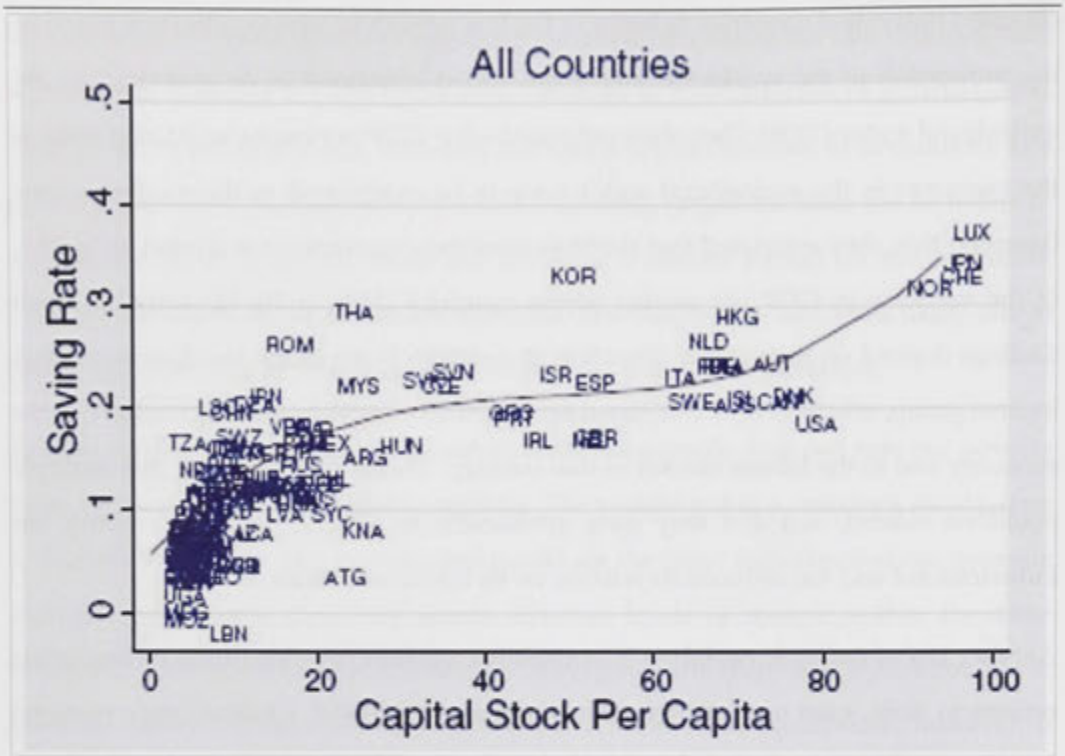
where the inclusion of 67 different variables were sensitivity tested, and found that the relative price of capital goods to consumption goods displaced the rate of investment as the one of the most robust explanatory variables as a determinant of growth (2004). They noted that when it was included, the coefficient on the rate of investment as a proportion of GDP declined in magnitude (becoming negative). Since the inclusion of the relative price of capital goods did not have a similar impact on the coefficient estimates of any of the other control variables, this observation was most likely due to correlation between the rate of investment, and the price of capital goods.

This strong evidence in support of conditional convergence does not rule out poverty traps or the existence of multiple equilibria. The variables that a country's steady-state is conditioned upon in the neo-classical model are the same variables that can generate multiple equilibria if they vary across different levels of income within the same country. As a result, a test for conditional convergence will show that a poor country is growing slowly because that country is close to a low-level equilibrium, however, it cannot test for the existence of multiple equilibria, or the possibility that there exists a higher level equilibrium that can be reached once a critical income threshold is surpassed. Bloom et. al. (2003) explicitly tested for whether or not the existence of multiple equilibria is supported by the available data. They used maximum likelihood estimation to test for whether a model with a single possible equilibrium or a model with two possible equilibria for each country fit the available data best. They found that the two-equilibria model fit the data best, and that around 85 % of the countries in their sample fell into the low income equilibrium category. They also found that some countries far away from the equator have a higher probability of converging to their high income equilibrium than countries that are close to the equator, and that it is easier for countries with 'favourable geography' — that is, countries situated on the coast with high levels of rainfall — to move from the low income equilibrium to the high income equilibrium than it is for landlocked countries that have lower levels of rainfall. While they argued that geographic location is not the *only* factor that determines a country's income or equilibrium, they also acknowledged that their paper did not explore how multiple equilibria arise, or how a country that is converging on the low income equilibrium can change its growth path so that it can converge on the high income equilibrium.

Graham and Temple expanded on this work, and conducted an analysis where they allocated individual countries as being in the low or high income equilibrium based on the proportion of the workforce and value added contained in or generated by the agricultural sector (2006). They then estimated what GDP per capita *might* be if some of the resources in the agricultural sector were to be redeployed to the modern sector. Based on this, they estimated that multiple equilibria accounted for around 15 to 25 % of the variation in GDP per worker across countries (2006, p. 5). Nevertheless, their findings depend on their initial allocation of countries being in the low income or high income group, which in turn was based on the relative importance of agriculture to the economy and to the labour market of that country. This in turn assumed that multiple equilibria existed, and that they were attributable to whether or not a country has industrialised and has reduced its reliance on its traditional sector.

Another test of multiple equilibria is to establish whether non-linearities, or increasing returns to scale, exist over critical parts of the growth model. Chakraborty's work on endogenous longevity found that threshold effects applied to household decisions to invest in education, because a certain income threshold was associated with greater public spending on health and increases to longevity, which in turn provided a greater incentive for human capital accumulation that would generate a higher rate of growth and higher incomes (2004). In their analysis of the existence of poverty traps, Kraay and Raddatz (2007) conducted empirical work on a cross-country dataset, plotting the average rate of saving between 1970 and 2000 in individual countries against their capital to labour ratios. Their hypothesis was that if the saving trap were a barrier to growth, then there should be a rapid acceleration in the rate of saving once a critical capital to labour ratio was achieved. That is, once the marginal product of labour — and the payments to labour associated with it — crossed a critical threshold, the rate of saving would increase because workers were earning enough to meet their basic needs, and have something left over to save. Kraay and Raddatz did not identify this sort of acceleration in their dataset (see Figure 1.8), and from this, they concluded that the historical relationship between aid, saving and growth is not consistent with escapes from poverty traps (2007).

FIGURE 1.8 RATE OF SAVING AND THE CAPITAL TO LABOUR RATIO



Source: Reproduced from (Kraay and Raddatz, 2007)

Their analysis, however, did not control for differences between countries except with respect to their stocks of capital per capita and their rates of saving. Given that the analysis was conducted across different countries, the exclusion of other variables implies that the analysis assumed that all countries are on the same growth path towards the same steady-state, albeit at different stages of development. The strong empirical case for conditional, as opposed to absolute, convergence means that the relationship between saving and the capital to labour ratio across different countries cannot meaningfully be used to draw conclusions about the relationship between saving and the capital to labour ratio in a single country over time. Finally, since they focused on the rate of saving rather than the rate of investment, their analysis also implicitly assumed that all of the countries included had closed economies, which is not the case.

In his assessment of the existence of poverty traps, Easterly (2005) focused on the rate of investment, rather than the rate of saving. He defined poverty traps as successive periods of zero, or close to zero, growth, and argued that since almost no country has exhibited successive periods of zero growth, poverty traps did not exist. Easterly also

argued that in the few instances where a country demonstrated a sudden burst of growth that was sustained over subsequent periods, this acceleration could often not be attributed to the inflow of foreign aid, and that instead, it was improvements in institutional quality that led to sustained economic growth (Easterly, 2005). Easterly's finding — that improvements to institutional quality (using information from the Polity IV database as a proxy) are linked with sustained economic growth — has a strong intuitive appeal. His definition of both the poverty trap and the escape from the poverty trap, however, are somewhat arbitrary — a fact that he acknowledged. The existence of a poverty trap does not mean that the economy experiences zero growth — in the case of Malthus' population trap, incomes per capita fluctuated as changes to income were followed by changes to the population. And even in the neo-classical model, countries may have a zero rate of transitional growth, but they have a long-run rate of growth equal to the exogenous rate of technological progress meaning that even very poor countries can exhibit positive rates of growth while still being mired in a low-level equilibrium.

1.5 CONCLUSION

This chapter discussed the various explanations for the divergence in the incomes of rich and poor countries. While there is strong evidence for conditional convergence, this evidence does not by itself rule out the existence of multiple equilibria. Testing for multiple equilibria is problematic, as it requires some assumptions about a country's counterfactual, such as what income, investment and saving might look like if that country were to have better health, education, institutional quality, or production technologies than it currently does. Added to this is the complication that many of these variables are interlinked, and it is difficult to separate out the impacts of, say, good population health from good educational attainment, since countries that have one usually have the other. One alternative is to look for evidence of changes to variables such as saving, health, education and institutions in response to changes in income, and once again, the evidence presented is mixed. At the same time, it is not necessary for poor countries to fund expenditure on health, education and physical capital out of their own incomes, when some of these expenditures — particularly

physical capital, which can be collateralised — can be financed by borrowing from the rest of the world.

The empirical work in subsequent chapters of this thesis applies a simpler test of whether or not poverty is a barrier to growth — that is, whether an increase in a poor country's rate of saving is retained as an increase in the rate of investment in physical capital. In the national accounting sense, an increase in income may be allocated across an infinite number of consumption or investment aggregates. In a given period, the national accounting concept of saving is what is left of income after decisions about consumption have been made. Since the national accounts treat expenditure on health and education as consumption, saving can only be allocated as domestic or foreign investment. If a poor country has a low rate of investment in physical capital solely because people in the country have limited means to invest then everything else being an equal, an increase in that country's rate of saving — for example, through an inflow of foreign aid — should be retained as an increase in the rate of investment. If it is not, then the simple saving trap is not the only barrier to growth that this country must overcome.

The next chapter presents and discusses the literature on open economy models of growth, the evidence on international capital mobility, and the extent to which countries' rates of saving are the same as their rates of investment.

2 CAPITAL ACCUMULATION IN AN OPEN ECONOMY

2.1 INTRODUCTION

As the previous chapter discussed, for the simple saving trap to be a country's primary barrier to growth, a necessary condition is that the country's rate of saving must rise with income. Even where saving rises with income, the simple savings trap can only be a country's primary barrier to growth where that increase in saving is retained as investment in physical capital — the sufficient condition. When both of these conditions hold, then a sufficiently large inflow of foreign aid or investment should lead to an increase in the stock of capital, and trigger a virtuous cycle towards higher incomes. If both conditions do not hold, then there are other aspects of development that must be addressed in addition to the rate of saving. These are health and education outcomes, institutional quality and so on — the variables that influence the production technology, and the same variables that growth economists use to condition the expected steady-state levels of capital and income per capita for individual countries.

As long as the international movement of goods and capital is not restricted, open economy growth models predict that a country will import capital if its marginal product of capital is higher than the rest of the world on average, and export capital if it is lower. The previous chapter outlined the rationale for countries' rates of saving increasing with income. A neo-classical growth model would predict the opposite for rates of investment, since the richer a country is, the lower its marginal product of capital becomes — all other things being equal. If, as these models predict, the rate of saving rises with income while the rate of investment falls, investment and saving are not positively linked. This means that the necessary condition is met, while the sufficient condition is not, which means that the saving trap cannot be the only barrier to growth. In 1980, Feldstein and Horioka conducted an empirical study on the relationship between rates of saving and investment across OECD countries, and found that they *were* closely and positively correlated. Furthermore, the correlation was

one-to-one, such that the variation in the rates of saving across countries could almost entirely explain the variation in the rates of investment across the same countries. From this, the authors concluded that any change in a country's rate of saving would be transmitted entirely as a change to the same country's rate of investment, implying that while economies might be open in practice, they behaved as though they were effectively closed. This in turn would mean that for poor countries, the rate of investment would be limited by what that country could afford to save, rather than the country's ability to attract foreign investment. As a result, the prediction of the neo-classical model — that diminishing marginal returns would drive the flow of capital from rich countries to poor — would not be observed.

The theoretical and the empirical literature are at odds with one another when it comes to international capital flows in the context of economic growth. The neo-classical growth model can be adapted to the open economy, however, it is limited in the extent to which it can explain the movement of capital across borders, implying that households devote all of their saving into either domestic or foreign investment entirely, with no portfolio balance. Barro and Sala-i-Martin adapted the Ramsey-Cass-Koopmans for the open economy and allowed for households to split their saving between domestic and foreign investment, but generated a number of counterintuitive outcomes, or required counterintuitive assumptions to generate meaningful outcomes — flaws that the authors themselves acknowledged (2004). The early empirical work, by contrast, strongly implies that countries' rates of saving are identical to their rates of investment, and that capital is not internationally mobile.

This chapter examines the current theory and evidence in the literature on the relationship between investment and saving in open economies. The first section presents a discussion of open economy versions of the Solow-Swan and Ramsey-Cass-Koopmans models of economic growth. The second section discusses Feldstein and Horioka's empirical results, the apparent paradox that the findings pose in light of what the theories predict and the results obtained by others asking the same question. The third section discusses theories of international capital movement that attempt to explain how an unrestricted and competitive international market for capital can be

reconciled with Feldstein and Horioka's results. The fourth section summarises and concludes.

2.2 NEO-CLASSICAL GROWTH AND THE CURRENT ACCOUNT

At a country or economy-wide level, investment and saving are defined, measured and reported using the national accounting framework. GDP is estimated as the sum of private consumption (C), public consumption (G), public and private investment (I) and exports (X) less imports (M).

$$GDP = C + G + I + X - M \tag{2.1}$$

Gross national product is similar in concept to GDP, however, being 'national' rather than 'domestic' means that the scope of economic activity that is recorded is based on the resident status of individual agents rather than the geographic location in which production occurs. 'Gross national product' is also called 'gross national income' (GNI), since it reflects the actual payments received by the residents of a particular country, and is estimated as GDP plus net factor payments from the rest of the world (F).[7] Saving is measured as a residual — since it cannot be directly observed — and is defined as the difference between what is earned and what is consumed in a given period. As a result, estimates of saving differ depending on whether they are derived using GDP or GNI. Gross domestic saving (S_D) is derived from GDP:

$$\begin{aligned} S_D &= GDP - C - G \\ &= I + EX - IM \end{aligned} \tag{2.2}$$

Gross national saving (S_N) is derived from GNI, with the addition of net transfers from the rest of the world (R):[8]

---

[7] Factor payments are the net compensation of employees, investment income from the ownership of foreign financial claims (interest, dividends, rent, etc.), and nonfinancial property income (patents, copyrights, etc.) paid to non-residents.

[8] In the balance of payments, transfers are recorded whenever an economy receives goods, services, income, or financial items without a quid pro quo. All transfers not considered to be capital are 'current transfers', otherwise they are 'capital transfers' THE WORLD BANK (2008) World Development Indicators Online. The World Bank..

$$
\begin{aligned}
S_N &= GNI - C - G + R \\
&= GDP + F + R - C - G \\
&= S_D + F + R
\end{aligned}
\tag{2.3}
$$

National saving can also be estimated using a country's financial accounts, where the change in a country's international financial position — or the acquisition of foreign assets less the incurrence of foreign liabilities — is equal to the sum of national saving and investment. The international financial position is the stock of a country's foreign financial assets and liabilities, made up of its holdings of foreign direct investment (*FDI*), portfolio investment (*PI*), other investment (*OI*) and reserves (*RES*).

$$
\begin{aligned}
\Delta IFP &= |\Delta FA| - |\Delta FL| \\
&= \Delta FDI + \Delta PI + \Delta OI + \Delta RES \\
&= S_N + I
\end{aligned}
\tag{2.4}
$$

The maximum value that saving can take is constrained by income. The minimum possible value of saving is limited only by an agent's ability to borrow in order to finance extra spending, since saving can be less than zero when consumption is higher than income. Economic models often characterise an agent's ability to borrow as the discounted sum of expected future streams of income. Effectively, the rate of saving as a proportion of income cannot be higher than 100 % but can be infinitely negative.

Unlike saving, investment can be directly observed and estimated as expenditure on goods and services designated as 'fixed assets' or capital goods. These include: 'land improvements (fences, ditches, drains, and so on); plant, machinery, and equipment purchases; and the construction of roads, railways, and the like, including schools, offices, hospitals, private residential dwellings, and commercial and industrial buildings' (The World Bank, 2008). The measurement of investment also includes the net change in stocks or inventory — goods that have been produced, but which have not as yet been purchased. As a result, if expenditure on capital goods is low, and if there is a significantly large reduction in inventory, then the estimate of investment can be less than zero. The measure of investment that includes changes in inventories is 'gross capital formation', and the measure of investment that excludes changes in inventories is 'gross *fixed* capital formation'. The minimum and maximum values that investment can take are the mirror opposite of saving. The rate of investment as a

proportion of income cannot be lower than 0 %, since there can be no negative expenditure on capital goods, but it can be infinitely positive, constrained only by an agent's ability to borrow.

In the absence of restrictions on the international movement of goods and capital, and given that investment and saving have entirely different relationships with income, there is no reason why a country's levels or rates of investment and saving should be the same as one another. Not all saving need be invested domestically, or even invested at all. Since saving is estimated as a residual, its measurement is vulnerable to errors in the estimation of the components that make up income and expenditure.[10] Even if income and expenditure can be comprehensively and accurately measured, agents' decisions about investment and saving are motivated by different considerations, and each has different substitutes. Those who save because they want to set something aside for another day, or so that they have a means of supporting themselves in the future, may do so in a number of ways.[11] Investment is an input into the production process — whether through the direct purchase of capital goods, or through the purchase of a financial instrument that in turn finances the purchase of capital goods — and this input can be sourced either domestically or internationally.

The difference between a country's investment and saving is shown in its current account, from the balance of payments:

$$\begin{aligned} CAB &= GNI - C - G - I + R \\ &= S_N - I \\ &= EX - IM + F + R \end{aligned} \tag{2.5}$$

[10] Further, there is no way to determine whether the difference between what is recorded as income and what is recorded as expenditure is used by households to formally augment the stock of physical capital — domestically or overseas — or whether it is used in black market transactions that cannot be recorded, stashed inside the mattress as currency, or smuggled out of the country and into a private foreign bank account.

[11] Examples include using family networks (agents depend on their parents when they are too young to work, and repay this by taking care of their parents once they are old enough to work and their parents are retired), or the purchase of stores of wealth other than designated capital goods (jewellery, collectors' items, and other valuables).

As equation (2.5) shows, a country's current account balance is determined by more than simply investment and saving decisions, since it also captures the net international flow of trade in goods and services. Equally, as implied from equation (2.4), it reflects the net change in a country's international financial position, or the change in the proportions of foreign assets and liabilities. Understanding what drives saving, investment and the current account balance on a national level is complicated by the fact that the actions of one domestic sector (government, business or household) may be off-set by the actions of another, so that neither is distinguishable at an aggregated level in the national accounts. For example, unexpectedly high government spending may be off-set by equally high private saving, as households prepare for higher taxes in subsequent periods. This interplay between the sectors is not always reflected in models where the behaviour of a country's economy is characterised as the behaviour of a representative, optimising household — particularly since these households own firms, and elect governments.

2.2.1 EXOGENOUS SAVING

In the Solow-Swan model, it is traditional to have a fixed, exogenous rate of saving, which is equal to the rate of investment in a closed economy. In an open economy, the rate of saving can still be fixed and exogenous, but investment decisions are made based on where investment is most profitable. In a scenario with absolute convergence, capital would flow from rich countries to poor countries. Lucas (1990) observed that: capital did not appear to be flowing from capital rich to capital poor countries; this ran counter to expectations consistent with diminishing marginal returns to capital; and the discrepancy might be explained if cross-country differences in stocks of human capital, or in political and sovereign risk were taken into account. In the case of the former, the return on investment in poor countries would be reduced as their lower stocks of human capital were taken into account. And in the case of political or sovereign risk, the marginal product of capital might be unaffected, but the likelihood of an investor receiving that return would be reduced. Benge and Wells, in a diagrammatic analysis of determinants of the current account in a small open economy, noted that the choice of the rate of saving affected patterns of consumption

and wealth, but that it was the choice of the rate of investment that affected the capital stock and flows of output (2002). Further, an increase in the rate of productivity growth would lead to a reduction in the current account surplus — that is, countries with superior production technology would be expected to import capital from the rest of the world. All of these explanations fit within the framework of the neo-classical model where a country's steady-state is conditioned on variables that drive differences in production technologies across countries — for example, human capital accumulation and institutional quality both perform well in cross-country growth regressions (Barro and Sala-i-Martin, 2004).

2.2.2 ENDOGENOUS SAVING

In the Ramsey-Cass-Koopmans model, the rate of saving is endogenous because the level of consumption is dynamically optimised. Barro and Sala-i-Martin (2004) augmented the model to allow for foreign ownership of capital. Households maximise utility by choosing consumption in each period:

$$U = \int_0^{\infty} u\left[c(t)\right] \bullet e^{nt} \bullet e^{-\rho t} dt \tag{2.6}$$

Since households can borrow from or lend to the rest of the world, the budget constraint is:

$$\begin{aligned} \dot{a} &= w_i + (r - n_i) \bullet a_i - c_i \\ &= w_i + (r - n_i) \bullet (k_i - d_i) - c_i \end{aligned} \tag{2.7}$$

Wealth (a_i) is defined as a country's stock of capital (k_i), less its net debt (d_i) to the rest of the world. Each country (i) has its own consumption (c_i), wealth (a_i), rate of population growth (n_i), rate of depreciation (δ_i), rate of technological progress (g_i), stock of physical capital (k_i), wages (w_i) and debt (d_i). Each country (i) is assumed to be small, so that its saving and investment decisions have no direct, individual impact on the exogenous world interest rate (r). Within countries, firms maximise profit, defined as the value of output less payments to factors of production:

$$\pi_i = F(K_i, L_i) - (r + \delta_i) K_i - w_i L_i \tag{2.8}$$

Firms are perfectly competitive price takers, so labour and capital are paid their marginal products. In units of capital per effective worker, the profit maximising conditions for firms are given as:

(2.9) $$f'\left(\hat{k}_i\right) = r + \delta_i$$

(2.10) $$w_i = [f(\hat{k}_i) - \hat{k}_i \bullet f'(k)] \bullet e^{g_i t}$$

Equation (2.10) is substituted into equation (2.7) to obtain the following equation of motion for wealth per effective worker:

(2.11) $$\dot{\hat{a}} = f\left(\hat{k}_i\right) - (r + \delta_i) \bullet (\hat{k}_i - \hat{a}_i) - (g_i + n_i + \delta_i) \bullet \hat{a}_i - \hat{c}_i$$

The change in wealth per effective worker is the value of production less: rents owed to foreign investors; the reduction in wealth per effective worker due to depreciation of the existing stock, and growth in the number of effective workers; and what is consumed. The model recognises total assets (a_i), the country's stock of capital (k_i) and net ownership of foreign capital (d_i, which can be positive or negative). If the change in wealth is positive, then saving is positive.

If a country has more capital per effective worker than its open economy steady state — the level that fulfils the profit maximising condition shown in equation (2.9) — it will export capital, because its return on capital is necessarily lower than in the rest of the world. Countries are assumed to be using the same production technology. The steady-state levels of output and rates of growth are known, since countries' rates of growth in this neoclassical model are the exogenous rate of technological progress (g_i). Since capital can move freely across borders, convergence to the steady-state is instantaneous — something that the authors acknowledge as a shortcoming of the model, since instantaneous convergence is not supported by the data. So that capital accumulation does not centre around one country (to the point where this country is large enough to affect the world interest rate) and so that the growth in wages is less than the return on capital (so that the present value of future wages is finite), the authors make the following assumption about the world interest rate:

(2.12) $$g_i + n_i < r \leq \rho_i + \theta_i g_i$$

That is, the world interest rate is assumed to be higher than the rate of growth in aggregate output. It is also less than or equal to the rate of interest that would apply if the economy were closed. This gives the following function for consumption per effective worker in an open economy is:

$$\hat{c}_i = \left(\frac{1}{\theta_i}\right) \cdot \left[\rho_i - r \cdot (1-\theta_i) - n_i \theta_i\right] \cdot \left[\hat{a}_i(0) + \frac{\left(\hat{w}_i^*\right)_{open}}{r - g_i - n_i}\right] \cdot e^{-\left[\frac{(r-\rho_i-\theta_i g_i)}{\theta_i}\right] \cdot t} \tag{2.13}$$

The power to which e is raised is either negative by assumption (from equation (2.12)) — which means that consumption per effective worker falls over time, and approaches zero as t approaches infinity — or it is zero, in which case consumption per effective worker is constant over time. The same is true of wealth, since wealth per effective worker is given by the following expression:

$$\hat{a}_i = \left[\hat{a}_i(0) + \frac{\left(\hat{w}_i^*\right)_{open}}{r - g_i - n_i}\right] \cdot e^{-\left[\frac{(r-\rho_i-\theta_i g_i)}{\theta_i}\right] \cdot t} - \frac{\left(\hat{w}_i^*\right)_{open}}{r - g_i - n_i} \tag{2.14}$$

If $r = \rho_i + g_i\theta_i$, then wealth is constant over time. If $r < \rho_i + g_i\theta_i$, then wealth not only shrinks over time, but approaches the negative term on the far right of equation (2.14). Both ρ_i and θ_i are indicators of patience — the rate at which future utility is discounted, and rate of inter-temporal substitution respectively. The most patient country will have the highest values of ρ_i and θ_i. To solve for the world equilibrium, Barro and Sala-i-Martin assume that g_i and n_i are the same across all countries. The exponent in equations (2.13) and (2.14) varies only according to countries' patience. The most patient country has $r = \rho_i + g\theta_i$, whereas for all of the other, less patient countries, $r < \rho_i + g\theta_i$.

From this, wealth and levels of consumption will decline faster in countries that are relatively more impatient, which — from Lawrance's findings — are more likely to be poorer countries. Conversely, the most patient country will accumulate all of the world's assets over time. In order to forestall instantaneous speeds of convergence, the authors augment the model by allowing ρ_i and θ_i to vary by income, so that consumption does not go to zero, and wealth does not run to the negative. This requires counterintuitive assumptions about the way in which the preference

parameters will change with respect to income — households must be more patient when they are poorer, which is counter to both intuition and evidence (Barro and Sala-i-Martin, 2004). Further, convergence to the steady-state is still instantaneous, even under these circumstances.

The speed of convergence can be slowed by introducing credit constraints that retard the flow of capital, and effectively allowing r to vary across countries. This means that countries are limited with respect to how much they can borrow, and that the return on investment domestically can be considerably different to the return on investment internationally. Barro and Sala-i-Martin achieve this by distinguishing between human and physical capital — the former which can only be locally owned, and the latter which can be domestically or foreign owned. The rate of growth depends on the accumulation of both human and physical capital, which are complementary inputs into the production function. The speed at which the economy grows in transition is limited by the speed at which the stock of human capital grows. This allows for a finite speed of convergence, a non-zero level of consumption and a non-negative stock of wealth. The authors note, however, that the global equilibrium results in credit constraints binding all countries, except for the most patient country. And because the most patient country is not credit constrained, it can accumulate both physical and human capital at infinite speed from the rest of the world, and reach its steady-state instantaneously.

2.3 THE FELDSTEIN AND HORIOKA PUZZLE

The neo-classical model can only meaningfully be applied to motivating the direction of capital movement intuitively, rather than formally. In doing so, the open economy versions of both the Solow-Swan and the Ramsey-Cass-Koopmans model predict that, all else being equal, capital should flow from capital rich countries to capital poor countries. As a result, the international flow of capital should ensure that the marginal product of capital is the same across all countries, and that all countries are converging toward the same level of GDP per capita, if not the same levels of wealth and/or consumption. Since this is clearly not the case, either everything else is not equal, or there is insufficient international capital movement. Thirty years ago, Feldstein and

Horioka undertook an analysis of rates of investment and saving in OECD countries and found that rates of saving were perfectly correlated with rates of investment for the years 1960 to 1974 (1980). They concluded from this that there was little to no international capital mobility, since any change in a country's rate of saving was retained as investment. This finding ran counter not only to the predictions of neo-classical growth theory, but also to the prevailing belief at the time that capital markets were unrestricted and efficient. This section describes and explores the Feldstein and Horioka Puzzle (henceforward referred to as 'the Puzzle').

2.3.1 THE ORIGINAL STUDY

Feldstein and Horioka used a simple model to conduct their analysis, and obtained a powerful result that held even as the model was augmented (1980). To begin with, they compared rates of gross saving and investment (as proportions of GDP) in individual OECD countries, and found that these were very close to one another in magnitude, implying that the current accounts of these countries were in balance. Table 2.1 shows Feldstein and Horioka's regression results based on the following specification:

$$\left(\frac{I}{Y}\right)_i = \beta_0 + \beta_1 \left(\frac{S}{Y}\right)_i \tag{2.15}$$

The authors found that for a sample of sixteen OECD countries[13] between the years 1960 and 1974: the variation in the rate of saving explained 83 to 94 % of the variation in the rate of investment; and the coefficient on the rate of saving was close to one.

TABLE 2.1 GROSS DOMESTIC SAVING RATIOS ON GROSS INVESTMENT RATIOS

Period	β_1	t-stat	R^2	n
1960-64	0.91	15.15	0.94	16
1965-69	0.87	8.63	0.83	16
1970-74	0.87	9.47	0.85	16
1960-74	**0.89**	**11.99**	**0.91**	**16**

Source: (Feldstein and Horioka, 1980, p. 321)

[13] The countries in the sample were Australia, Austria, Belgium, Canada, Denmark, Finland, Germany, Greece, Ireland, Italy, Japan, the Netherlands, New Zealand, Sweden, the United Kingdom and the United States of America. France, Luxembourg, Spain and Switzerland were excluded due to lack of consistent data at the time.

From this, the authors inferred that there was close to no international movement in capital between OECD countries — a finding that characterised an apparent paradox, given the relative ease with which capital could move from one country to another. Even twenty years later, the paradox was categorised as one of 'the six major puzzles in international macroeconomics' (Obstfeld and Rogoff, 2001).[14] While Feldstein and Horioka's 'headline results' were obtained using the simple model shown, they augmented the model by — variously — introducing a squared term for the rate of saving, controlling for the openness of each of the economies (using trade as a proportion of GDP), the size of the economies (using GDP itself), and controlling for possible endogeneity in the rate of saving in a two-stage least squares regression. In each case, the estimate for β_1 remained statistically significantly close to one, and they concluded that it was likely that 'portfolio preferences and institutional rigidities impede the flow of long-term capital among countries [and that] increases in domestic saving will be reflected primarily in additional domestic investment' (Feldstein and Horioka, 1980, p. 328).

2.3.2 ANALYSIS BY OTHERS — PRIOR TO 1990

Since the initial study, many others have repeated the analysis, and while most of them agreed with Feldstein and Horioka's findings, they disputed the methodology and the conclusion that capital was not mobile. This was a criticism that Feldstein and Horioka acknowledged in their original study, particularly since the sample contained a group of relatively developed and financially sophisticated countries. They allowed that a high value for β_1 could still 'reflect other common causes of the variation in both saving and investment' (Feldstein and Horioka, 1980, p. 328), but noted that the burden of identifying these common causes lay with those who argued in favour of perfect

[14] The six major puzzles in international macroeconomics that the authors defined were: (i) why consumers seem to have a strong preference for domestically manufactured goods and services; (ii) why investors seem to have a strong preference for domestic equity assets; (iii) why current account imbalances in OECD countries are small relative to saving and investment (the Puzzle); (iv) why consumption is not more strongly correlated across OECD countries; (v) why exchange rates are so volatile and disconnected from economic fundamentals; and (vi) how it is possible that the half-life of real exchange rate innovations can be three to four years.

international capital mobility. Subsequent studies have attempted to do so, but in the main, the rate of saving has had strong explanatory power — at least up until 1990.

One of the criticisms of the original study was that the sample was limited to OECD countries, many of which were large economies. Saving decisions in these large economies would affect global interest rates, and through them, rates of investment in large *and* small economies. For example, an increased rate of saving in a large economy would lead to a fall in global interest rates as borrowing became cheaper. As the cost of borrowing fell, the rate of investment would rise, explaining why the close correlation was observed only in samples of rich countries (Apergis and Tsoumas, 2009). This criticism is supported somewhat by the fact that the rate of saving and investment in non-OECD countries was not as closely correlated as it was in OECD countries. Dooley et. al. (1986) used the same specification as Feldstein and Horioka, and undertook the analysis for groups of both developed and developing countries. They found a weaker relationship (as evidenced by a β_1 of less than one) for developing countries compared to the OECD countries, but noted that this difference was not statistically significant (see Table 2.2). In fact, they found that the only group of countries for which rates of investment and saving were not correlated was for countries 'that depend primarily on aid to finance current account imbalances' (Dooley et al., 1986, p. 37).

TABLE 2.2 THE RELATIONSHIP BETWEEN GROSS SAVING RATIOS AND GROSS INVESTMENT RATIOS — DEVELOPED AND DEVELOPING COUNTRIES

1960-73	β	t-stat	R^2	n
Developing	0.47	5.88	0.40	50
Developed	0.75	7.17	0.79	14
Difference*	0.28	1.26		64
1974-84	**β**	**t-stat**	**R^2**	**n**
Developing	0.60	8.48	0.59	50
Developed	0.74	4.25	0.57	14
Difference*	0.13	0.48		64

Source: (Dooley et al., 1986)

Notes: * The difference between the coefficient estimated for developing countries and the coefficient estimated for developed countries, calculated using a dummy variable (1 if the country is developed) and an interaction term.

In seeking to refute Feldstein and Horioka's conclusions, several subsequent papers reference Sachs (1981) as having shown that investment is more closely linked with the current account balance in developing countries than it is with saving. Sachs compared

indicators across fifteen OECD[15] and ten developing countries[16] between 1965 and 1979 and looked at the relationships between investment, national saving and the current account balances as proportions of GNI in these countries. For developing countries, he observed that while 'economic and political thinking [was] still caught up in the mercantilist idea that deficits reflect overspending and require adjustment' (1981, p. 263), for the most part, current account deficits in developing countries were driven by borrowing to finance investment, rather than borrowing to finance consumption.

For the fifteen OECD countries, Sachs estimated the specification shown in equation (2.16), where the difference in the variables was taken as the average for 1974-79 less the average for 1968-73:

$$\Delta\left(\frac{CAB}{GNI}\right) = \phi_0 + \phi_1\Delta\left(\frac{I}{GNI}\right) + \phi_2\Delta\left(\frac{M^{oil}}{GNI}\right) \tag{2.16}$$

M^{oil} in the specification is the value of imports of oil. In apparent contrast to Feldstein and Horioka's results, Sachs found a close correlation between the change in the rate of investment and the change in the current account ratio to GNI, with ϕ_1 = -0.59 (t-stat – 5.9) and ϕ_2 = -0.30 (t-stat -1.2) (Sachs, 1981, p. 250). The current account balance tended to deficit as domestic investment and the import of oil increased. This suggests that domestic investment was linked to borrowings from the rest of the world rather than to savings generated at home. When the variable for imports of oil (M^{oil}) was omitted from the regression, the coefficient on the rate of investment was still high, ϕ_1 = - 0.61 (t-stat - 6.2). When the rate of saving was used instead of the rate of investment, the regression produced a much weaker coefficient estimate of - 0.34 (t-stat - 1.0). This gives the peculiar implication that an increase in the rate of saving will also lead to a reduction in the current account, driving it towards a deficit.

---

[15] The countries included were Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Italy, Japan, the Netherlands, Norway, Sweden, the United Kingdom, and the United States of America. The difference between this sample and Feldstein and Horioka's OECD sample of countries is that Sachs omits Greece, Ireland and New Zealand, but includes France and Norway.

[16] The developing countries analysed were Argentina, Brazil, Chile, Colombia, Mexico Peru, the Phillipines, South Korea, Taiwan, and Thailand.

In fact, Sach's study supports Feldstein and Horiaka's findings, because a negative coefficient on both the change in the rate of investment and the change in the rate of saving implies that investment and saving are positively correlated. As equation (2.17) shows, the current account balance is the difference between saving and investment. All other things being equal, an increase in the rate of saving should lead to an increase in the current account balance. The fact that Sachs found a negative correlation between the two suggests that an increase in investment was being funded by increased saving, as well as a current account deficit. In addition, (2.17) shows that the coefficient on the rate of saving — when the CAB to GDP ratio is the dependent variable — is equal to one minus β_1, which is the coefficient on the rate of saving when the rate of investment is the dependent variable. Based on equation (2.17), an estimated γ_1 of - 0.34 implies a β_1 of 1.34, which means that there is a multiplier effect on increases in the rate of saving — something that can only occur if the country is importing capital from the rest of the world, and reducing its current account balance.

$$\begin{aligned}\left(\frac{CAB}{Y}\right) &= \left(\frac{S}{Y}\right) - \left(\frac{I}{Y}\right) \\ &= \left(\frac{S}{Y}\right) - \left[\beta_0 + \beta_1\left(\frac{S}{Y}\right)\right] \\ &= -\beta_0 + (1-\beta_1)\left(\frac{S}{Y}\right) \\ &= \gamma_0 + \gamma_1\left(\frac{S}{Y}\right)\end{aligned} \tag{2.17}$$

It should be noted that Sachs' sample includes Norway, a resource-rich, oil-exporting country that was not in Feldstein and Horioka's sample. Sachs shows that when Norway is omitted from the sample, ϕ_1 rises from -0.59 to -0.33 (t-stat -2.6), making it similar in magnitude to the estimated coefficient on the change in the rate of saving, and supporting a very close positive correlation between investment and saving (Sachs, 1981, p. 250).[17]

[17] Without Norway in the sample of countries, ϕ_2 remains largely unchanged (ϕ_2= -0.32, t-stat –1.5).

2.3.3 ANALYSIS BY OTHERS — POST-1990

Restricting the sample to developed countries, others have been able to replicate Feldstein and Horioka's findings, even after including and controlling for variables that were omitted in the original study, such as differences in population, production technology, and government expenditure (AmirKhalkhali et al., 2003; Tesar, 1991). Kraay and Ventura analysed the relationship between the current account balance and gross national saving as proportions of GNI for a group of thirteen OECD countries, generating estimates for γ_1 of 0.24 (*t-statistic* 8.14) for data averaged across the period 1973 to 1995 — an indirect confirmation of the Feldstein and Horioka result (2000). After 1990, however, the correlation is no longer as strong, even for OECD countries. Up until 1995, the data for OECD countries generated estimates for β_1 of around 0.6 — statistically significant and strongly positive, but not as compelling as the Feldstein and Horioka estimate of 0.89 (s.e.0.07) for 1960-74.

Obstfeld and Rogoff estimated a β_1 of 0.6 for gross national saving as a proportion of GDP, measured as individual country averages between 1990 and 1997 for twenty-four OECD countries (2001). AmirKhalkhali et. al. separated gross national saving into private and public saving for nineteen OECD countries, in order to test for whether or not crowding out occurred. The authors found that the rate of private saving was closely correlated with the rate of investment, although the estimated coefficient weakened from 1.02 (s.e. 0.11) for country averages in 1970-79 down to 0.62 (s.e. 0.09) for the same countries, averaged across 1990-99 (2003, p. 1144). Coakley et. al. estimated β_1 at 0.68 (s.e. 0.11) for twelve OECD countries using quarterly rates of national saving and investment averaged between 1980 and 2000 (2004, p. 584). They also found, however, that if country specific effects were controlled for in the regression, the average coefficient estimate on the rate of saving for the total sample of countries was nearly halved in comparison to the OLS estimator ($\beta_1 = 0.33$), and was no longer statistically significant (s. e. 0.18) (Coakley et al., 2004).

More recently, Helliwell replicated Feldstein and Horioka's methodology, extending both the sample of countries and the time period (2004). The countries in the sample were designated as either being one of the twenty-four OECD countries, or being a

non-OECD country, and he calculated five year average rates of gross national saving and investment as proportions of GDP for these countries from 1976 to 2000. Helliwell wrote that β_1 fell over time for OECD countries, and that the estimated coefficient for 'the global sample is always weaker for the global samples than for the OECD countries' (2004, p. 373). His results, however, actually show that the coefficients for the global sample in the 1981-1985 and 1991-1995 periods were higher than for the OECD sample (see Table 2.3). While the coefficient on the OECD sample was higher than for the global for the 1996 to 2000 period, neither are statistically significant at the 5 % level.

TABLE 2.3 THE RELATIONSHIP BETWEEN GROSS NATIONAL SAVING RATIOS AND GROSS INVESTMENT RATIOS

		OECD		NON-OECD		ALL COUNTRIES	
PERIOD	*n**	β_1	*t-stat*	β_1	*t-stat*	β_1	*t-stat*
1976-1980	95	0.80	6.65	0.70	12.15	0.68	13.65
1981-1985	103	0.53	4.04	0.57	9.20	0.55	10.10
1986-1990	110	0.60	6.94	0.51	9.58	0.52	11.27
1991-1995	130	0.42	5.30	0.59	11.29	0.56	11.81
1996-2000	136	0.17	1.63	-0.06	0.83	-0.06	0.94

Source: (Helliwell, 2004, p. 376)
Notes: The number of countries in the sample for each period (n) refers only to the non-OECD countries, and does not include the 24 OECD countries included in the global sample.

Partially in response to the findings in these subsequent studies, Feldstein (2005) acknowledged that estimates for β_1 had fallen over time — both for the sixteen countries in the original study, as well as for all thirty (current) OECD countries. He argued, however, that this result was driven by the equal weighting given to all of the countries in the sample, and that if the regression were weighted by GDP, β_1 for the original sixteen countries for the period 1992 to 2002 would increase from 0.19 (unweighted) to 0.57 (weighted) (2005, p. 4-5). Given that the criticisms of the 'large economy bias' that were discussed earlier were made with respect to the original, unweighted analysis, weighting the regression by countries' GDPs would be giving greater emphasis to the larger of the OECD economies, which would exacerbate the bias further.

In summary, the findings from the literature are mixed. When using the specification set out in equation (2.15), rates of investment and saving across countries are positively correlated. This result holds for more recent time periods up to 1995, and for

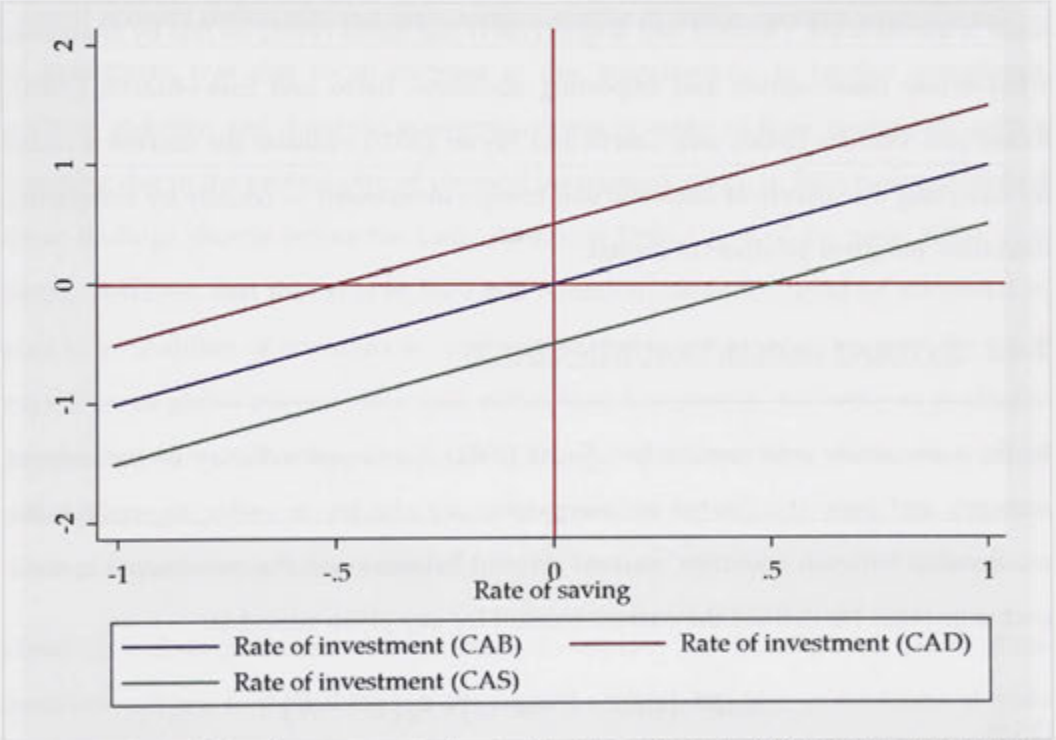
non-OECD countries. It also holds when national — rather than domestic — saving and investment are used. Some studies confirm the Puzzle as still being in effect over time and across different countries (AmirKhalkhali et al., 2003, Feldstein, 2005, Kraay and Ventura, 2000, Penati and Dooley, 1984, Tesar, 1991). Other studies show that: the correlation is weaker in developing countries (Helliwell, 2004, Sachs, 1981, Penati and Dooley, 1984) — although they argue that the difference is not statistically significant; that the coefficient estimated for OECD countries has weakened over time (Helliwell, 2004, Feldstein, 2005); or that the close correlation between rates of investment and saving does not mean that capital is not mobile (Coakley et al., 2004, Tesar, 1991). In their review of the literature, Apergis and Tsoumas concluded that: the majority of the studies that they referred to supported a strong correlation between countries' rates of saving and investment, albeit lower than that displayed in the earlier attempts; and that the majority of the results did not clearly validate the capital mobility hypothesis (Apergis and Tsoumas, 2009). On the face of it, the fact that developing countries' rates of investment are linked to their rates of saving would imply that the saving trap is a barrier to growth in these countries, even if it is not the only or most affecting one.

While the majority of the studies referenced may indeed have failed to validate capital mobility, the more recent studies have shown that the Puzzle has weakened over time in developed countries, and declined to near non-existence in the latter half of the 1990s. With respect to developing countries, the studies referenced show that the Puzzle has applied to developing countries to a lesser degree, albeit not always a statistically significantly lesser degree than richer countries. The weakening in the estimated coefficient on the rate of saving may demonstrate that capital is becoming more mobile, but it does not by itself rule out the existence of the saving trap. This is because it is still possible for omitted variables to bias the estimated coefficient on the rate of saving toward zero — something that is tested and discussed in Chapter 5. In the absence of additional variables, a reduced coefficient on the rate of saving implies either that rates of investment and saving are relatively independent of one another, or that the relationship between the two has grown more complicated, and additional control variables are necessary.

2.4 EXPLAINING THE PUZZLE

A coefficient on the rate of saving that is close to one does not by itself mean that there is little or no international capital mobility. It is also important to consider the intercept term — which is often not reported in the studies referenced — and whether or not it is significantly different than zero. If it is, then this implies that on average, the current accounts of the countries in the sample are not balanced. As equation (2.5) shows, the current account can be derived as saving less investment. If β_1 is equal to one, then β_0 is the reverse of the current account balance (being investment less saving). It is not necessary, however, for $\beta_0=0$ in order for $\beta_1=1$ as shown in Figure 2.1.

FIGURE 2.1 NON-ZERO ESTIMATES FOR THE CONSTANT



Note: CAB indicates a balanced current account, where investment is equal to saving. CAD indicates a current account deficit, and if the countries in the sample on average have the same CAD where investment is higher than saving, then the estimate of β_0 will be positive. The opposite is true for CAS, which indicates a current account surplus, where investment is lower than saving, and where the estimate of β_0 will be negative.

If countries' current account balances are also similar with respect to GDP, then it is possible to have a non-zero intercept term together with a co-efficient of close to one. It is unlikely that all of the countries in a sample will have the same current account to GDP ratio, and the larger the sample becomes, the less likely this will be — countries

cannot *all* be importing (exporting) capital, since at least one country has to export capital to (import capital from) the others. At the same time, it is possible for there to be a current account balance in every country simultaneously, while still allowing and observing international capital movement: countries can export and import capital in identical amounts to ensure the net change in their financial position is zero.[18]

Equation (2.5) shows that the difference between investment and saving in the national accounts reflects the balance on trade (net exports) as well as the change in the country's financial position (net overseas lending). In order to reconcile the Puzzle with the economic theory, authors have advanced theories on how these flows — the current and capital accounts — can net to zero, implying a one-to-one correlation between countries' rates of investment and saving even when economies are open and trade is unrestricted. Obstfeld and Rogoff (2001) and Sachs (1981) do this by analysing what drives consumption and importing decisions. Barro and Sala-i-Martin (2004), Kraay and Ventura (2000), and Caselli and Feyrer (2007) evaluate the current account by analysing the drivers of domestic and foreign investment — usually by comparing countries' marginal products of capital.

2.4.1 INTERNATIONAL TRADE IN GOODS

In the same study reference earlier, Sachs (1981) developed a theory of the current account, and how it adjusted to macroeconomic shocks, in order to analyse the relationship between countries' current account balances and the movements in their exchange rates. He defined the current account for any given period as:

$$\begin{aligned} CAB &= \left(GDP - C - G - I\right) + P_N\left(N^H - N\right) \\ &= \left(EX - IM\right) + P_N\left(N^H - N\right) \end{aligned} \tag{2.18}$$

The current account balance is given as GDP less consumption ($C + G$), less investment (I) which leaves net exports ($EX - IM$). This is similar to equation (2.5), except Sachs

[18] This does not align with neo-classical growth model's predictions of capital movement in an open economy

assumed that there are no international transfers or factor payments, and the consumption and import of one particular good — N — is identified separately. The expression $P_N(N^H-N)$ represents expenditure on an intermediate input that is critical to production (for example, oil). N_H is the volume that is domestically produced, and P_N is the world price at which the good is traded. Households, firms and the government operate in a two period model where whatever is borrowed from the rest of the world in the first period must be repaid in the second period, and vice versa.

Sachs argued that countries' rates of investment were the primary driver of changes in their current account balances due to 'world investment shifts', and attributed the sharp rise in investments in less developed countries as being financed by borrowing from the rest of the world — particularly in Mexico and Brazil. From this perspective, a current account deficit was not necessarily a matter of policy concern since the inflow of investment was due to an increase in the 'receptiveness to foreign investment, political stability, and domestic economic reform in many of these economies, with a resulting rise in the profitability of physical investment' (1981, p. 238). Sachs published these findings shortly before the Latin American Debt Crisis of the early 1980s. It is noted, however, that the crisis in the Latin American countries could be attributed in part to an inability of countries to service debt that was becoming increasingly more expensive as global interest rates rose, rather than investments not being as profitable as initially believed. Perhaps as a result of this, policy makers have remained cautious about managing the current account, and governments still intervene to minimise adverse impacts on exchange rates.

Obstfeld and Rogoff used this rationale to explain the Puzzle, and linked these decisions not just to the balance on the current account, but also to the terms of trade (2001). Like Sachs, the authors set up a two period model in which whatever is borrowed (lent) in the first period must be repaid (recovered) in the second period at the world interest rate, r^*. Households maximise utility by consuming the goods (C) that are available either locally (C_H) or imported (C_F) according to a constant elasticity of substitution preference function.

There is no production function. Instead, each country is endowed with one good and must trade with other countries to consume other goods. P_1 and P_2 represent the

average price that prevails in the home country in time periods 1 and 2, based on the willingness of consumers to substitute imported and locally available goods at prices P_F and P_H respectively. P_t is defined in each period t as:

(2.19) $$P_t = \left(P_{t,H}^{(1-\theta)} + P_{t,F}^{(1-\theta)} \right)^{\left(\frac{1}{1-\theta}\right)}$$

This means that the domestic real interest rate is a function of the world interest rate, as well as the expected change in the prevailing price between period one and two, which in turn is driven by how much of the domestic good (C_H) or foreign good (C_F) households consume (even though the prices of the individual goods do not change). This means that the domestic interest rate is:

(2.20) $$(1+r) = (1+r^*)\frac{P_1}{P_2}$$

Obstfeld and Rogoff introduced 'iceberg costs' (τ) into the model, where τ% of whatever is traded is lost or expires in transit. If households wish to consume more of the locally available good than their endowment, they will need to import it from the rest of the world. This means that the domestic price of the local good (P_H) varies according to how much of it is consumed in relation to how much of it is locally available. If more of the good must be imported, then the local price will be higher than the world price (P^*_H) due to the iceberg costs associated with import. If households consume less than what is available, the rest is exported and the domestic price is lower than in the rest of the world. And if households consume what is locally available and no more, then the domestic price falls somewhere between the export and import prices:

(2.21) $$\frac{P_H^*}{(1-\tau)} > P_H > P_H^*(1-\tau), C_H = Y_H$$

If the locally available good is exported in the first period, then it must be imported in the second and vice versa. This is what affects the domestic interest rate. As shown in equation (2.20), the real domestic interest rate is the world interest rate, after it is scaled by expected changes in domestic prices. Substituting equation (2.19) for the home

country's prices in periods 1 and 2 in equation (2.20) gives the following expression for the real domestic interest rate:

$$(2.22) \qquad (1+r) = (1+r^*)\frac{\left(P_{H,1}^{1-\theta} + P_{F,1}^{1-\theta}\right)^{\left(\frac{1}{1-\theta}\right)}}{\left(P_{H,2}^{1-\theta} + P_{F,2}^{1-\theta}\right)^{\left(\frac{1}{1-\theta}\right)}}$$

The price level varies according to whether the local good is imported or exported, which means that the real domestic interest rate also varies according to consumption and import decisions. If there is a current account surplus in the first period, there must be a current account deficit in the second period, which means that the domestic price level will be lower in the first period than in the second one, and so the real domestic interest rate will be lower than the world interest rate. The opposite is true if the country runs a deficit in the first period and a surplus in the second, as shown:

$$(2.23)(1+r^*)\frac{\left(\left[P_H^*(1-\tau)\right]^{1-\theta} + P_F^{1-\theta}\right)^{\left(\frac{1}{1-\theta}\right)}}{\left(\left[P_H^*/(1-\tau)\right]^{1-\theta} + P_F^{1-\theta}\right)^{\left(\frac{1}{1-\theta}\right)}} < (1+r^*) < (1+r^*)\frac{\left(\left[P_H^*/(1-\tau)\right]^{1-\theta} + P_F^{1-\theta}\right)^{\left(\frac{1}{1-\theta}\right)}}{\left(\left[P_H^*(1-\tau)\right]^{1-\theta} + P_F^{1-\theta}\right)^{\left(\frac{1}{1-\theta}\right)}}$$

Depending on the values of the various parameters, the difference between the real domestic and the world interest rate could be trivial, or substantial. Since the current account imbalance applies equally in both periods — albeit in opposite directions — a larger gross imbalance will lead to a more substantial difference between the world, and the real domestic interest rates.

Obstfeld and Rogoff used this rationale to explain why rates of saving and investment are so similar, since running either a large current account surplus or deficit would move the real domestic interest rate further away from the world interest rate. The authors used the following values — $r^* = 0.05$, $\tau = 0.1$, $\theta = 6$, and $P_H^* = P_F^* = 1$ — to show that the real domestic interest rate could be anything from +0.20 to -0.08. This means that a current account that is significantly unbalanced results either in borrowing being prohibitively expensive, or in lending being ruinously unprofitable. The authors noted that observed real domestic interest rates in OECD countries stay well within these bounds and that this, combined with the observed close correlation between rates of

investment and saving, explained why observed current account balances in OECD countries are small, with respect to GDP and GNI (2001, p. 20). Further, the authors regressed the inflation adjusted three-month interest rates of OECD countries against their current account balance to GDP ratios, and found that there is a negative relationship — as predicted by the model.

An important caveat is that their analysis was limited to OECD countries, which are large economies. Movements in the current account balances of some of these countries would affect global interest rates as well as individual domestic interest rates. Were this to happen, the impact would be similar to that predicted in the 'large country bias' criticism of Feldstein and Horioka's results. This does not invalidate Obstfeld and Rogoff's model, however, since a lower current account balance would lead to higher interest rates for both large and small economies. For large economies, this increase would apply to both the world and the domestic interest rate, while for small economies, it would be a purely domestic effect.

More problematic, however, is the fact that Obstfeld and Rogoff's model only addresses saving, and not investment. There is no role for investment in the model, since the local good is endowed in each period rather than produced. Since there is no capital in the model, interest rates cannot in any way be affected by considerations of the return on capital — the model does not allow for the net import or export of capital in response to different rates of return across countries. For example, running a current account deficit may increase the cost of borrowing as evidenced by the real domestic interest rate, however, if the return on the investment is sufficiently high, then it makes sense for countries to borrow from the rest of the world. Nevertheless, even with this shortcoming, the model provides a rationale for the observed lack of net capital flows, and in addition, can explain three of the other macroeconomic puzzles identified by the authors to some extent — the home bias in trade, the home bias in equity portfolios, and the low international consumption correlations. Added to which, the authors noted that the observed weakening in the correlation between rates of investment and saving over time could be linked to improvements in transportation technology, and reductions in tariffs and other barriers to trade, which would reduce the iceberg costs that drive the outcome in the model.

2.4.2 INTERNATIONAL CAPITAL MOVEMENT

Lucas (1990) used the properties of the Solow-Swan model to motivate international capital flows by defining the marginal product of capital in terms of output:

$$r = \alpha A^{1/\alpha} y^{(\alpha-1)/\alpha} \tag{2.24}$$

Using α=0.4 for both the USA and for India, Lucas argued that the marginal product of capital in India was roughly 58 times the marginal product of capital in the USA (1990, p. 92), and that if there truly were cross-country differentials in the marginal product of capital of this magnitude, then almost no investment should take place in rich countries at all. After allowing for differences in human capital accumulation and defining the marginal product in terms of output per effective worker, Lucas found that the marginal product of capital in India was still three times higher than that in the USA. The difference in marginal products of capital between the two countries was further reduced to 1.04 when the spill-over effects associated with human capital accumulation were controlled for, altering the specification of the marginal product of capital to:

$$r = \alpha A^{1/\alpha} y^{(\alpha-1)/\alpha} h^{\gamma/\alpha} \tag{2.25}$$

Lucas used a smaller α=0.25 together with γ=0.36 in order to obtain a marginal product of capital for India that was only 1.04 times greater than that of the USA — a considerable reduction from 58. Lucas also discussed the difference in risk, and the way in which contracts are enforced, between different countries. He explored a scenario in which capital flows only occurred between rich and poor countries where the former was the colonial power that administrated the latter. Further, he suggested that restricting capital flows to colonies would keep wages low, and that this was profit maximising behaviour for rich countries, since they had monopoly power over the goods produced by their colonies. This is not explored further here, since colonial arrangements and the 'monopoly power' condition are not as prevalent as in the scenario Lucas was exploring. Nevertheless, the colonial arrangement to some extent offset concerns about institutional quality and contract enforcement in poor

countries— in the absence of the former, the latter (increased political risk in poor countries) could explain the lack of capital flow.

Recent work by Caselli and Feyrer (2007) built on the idea that the marginal product of capital may not necessarily be higher in poor countries than in rich, and that a large part of the difference between marginal products of capital across countries could be attributed to incorrect measurement. Rather than specify a production function, the authors calculated the marginal product of capital using national accounts aggregates, in the following specification:

$$MPK = \alpha_K \frac{Y}{K} \tag{2.26}$$

Y is GDP, taken from the Penn World Tables (2002). K is the stock of reproducible capital and α_K is the capital share of income, which is effectively measured as one less the labour share of GDP, or one less the proportion of GDP made up by wages or the compensation of employees. When calculated in this way, and plotted against income per capita, there is a negative correlation between income and the marginal product of capital. The authors then constructed a corrected estimate of the marginal product of capital, denoted here as MPK_{CF}:

$$MPK_{CF} = \alpha_{RK} \frac{Y}{K} \frac{P_Y}{P_K} \tag{2.27}$$

The major changes are the inclusion of a price correction (P_Y and P_K), and an adjustment to the capital share of income. In this specification, P_Y and P_K are the prices of consumption and capital goods, since the relativities of these vary considerably between rich and poor countries. The authors do this to estimate the marginal product of a given value of capital, rather than the marginal product of a given number of capital items, which is done by scaling the unadjusted marginal product of capital by the ratio of consumption to capital good prices. This gives a result that more closely approximates a monetary return on a given value of investment — two countries may produce the same volume of output using the same volume of capital, but if the capital costs more relative to the value of the output in one country, the monetary return on capital in this country is lower than in the other.

The larger correction to the estimate was to the way in which the capital share of income was estimated and used. Instead of the capital share of income (α_K), the corrected estimate used the reproducible capital share of income (α_{RK}) so that the return on or depletion of non-reproducible assets such as land, minerals, forests, and other forms of natural wealth would not overstate the true return on reproducible capital. The authors assumed that the ratio of the share of income attributable to reproducible capital to the share of income attributable to non-reproducible capital was the same as the ratio of the total stock of reproducible capital to the total stock of non-reproducible capital. Here, N is the country's stock of non-reproducible, natural capital, estimated by the World Bank (2006):

$$\alpha_{RK} = \alpha_{K.2} \bullet \left[\frac{K}{(K+N)} \right] \tag{2.28}$$

In recognition of the fact that the capital share of income (α_K) is often overstated in poorer countries, Caselli and Feyrer use a corrected capital share of income ($\alpha_{K.2}$) which is derived using an alternative estimate of the labour share of income.

From an income perspective, GDP has three components — compensation of employees (COE), gross operating surplus (GOS) and gross mixed income (GMI — returns to labour and capital used in unincorporated enterprises). Poorer countries generally have a higher share of GMI than richer countries, because a larger share of people in poorer countries are self-employed (Gollin, 2002). Using just the share of COE of GDP would underestimate the labour share of income in countries that have a large share of self-employed workers, which would in turn overstate the capital share of income and through it, the marginal product of capital. Bernanke and Gürkaynak advanced two methods of correction, depending on the availability of data (2001). The first was to subtract GMI and indirect taxes from GDP, and to calculate COE as a share of what was left:

$$\alpha_L = \frac{COE}{GDP - Indirect\ Taxes - GMI} \tag{2.29}$$

An alternative correction was to scale the labour share of income by the proportion of employees to total workers:

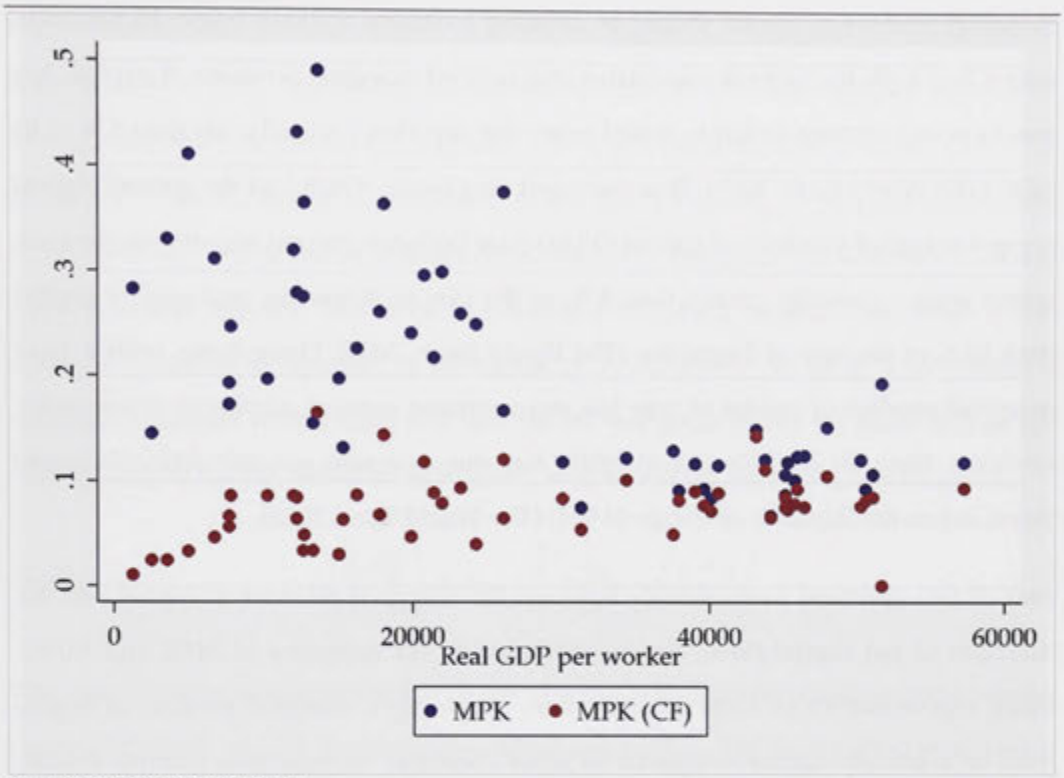
$$\alpha_L = \left(\frac{COE}{GDP - Indirect\ Taxes} \right) \times \left(\frac{Workers}{Employees} \right) \tag{2.30}$$

Caselli and Feyrer argued that once these adjustments were made, differences in the marginal product of capital across countries were largely eliminated. As Figure 2.2 shows, the difference between *MPK* and MPK_{CF} is much greater in poorer countries than in rich, although MPK_{CF} is smaller than *MPK* for almost all countries. The authors concluded that the reason that capital does not flow from rich to poor countries was satisfactorily explained. Further, they argued that since MPK_{CF} was similar in magnitude across rich and poor countries, capital was efficiently allocated across countries, and '[d]eveloping countries are not starved of capital because of credit-market frictions. Rather, the proximate causes of low capital-labor ratios in developing countries are that these countries have low levels of complementary factors, they are inefficient users of such factors (as Lucas [1990] suspected), their share of reproducible capital is low, and they have high prices of capital goods relative to consumption goods. As a result, increased aid flows to developing countries are unlikely to have much impact on capital stocks and output, unless they are accompanied by a return to financial repression, and in particular to an effective ban on capital outflows in these countries' (Caselli and Feyrer, 2007, p. 565).

While this conclusion may be the correct one, it is not supported by the data. The dispersion of estimates of MPK_{CF} across countries may appear smaller than that for the estimated *MPK*s when plotted on the same axes, however, Table 2.4 shows that for both sets of estimates, the mean is roughly double the magnitude of the standard deviation. This implies that the dispersion of MPK_{CF} relative to the mean is roughly the same as for *MPK*. Further, if MPK_{CF} is taken to represent the true rental rate of physical capital, then the difference between countries with the most and the least productive capital is even greater than when comparing *MPK*s. For example, the country with the highest *MPK* in 1996 was El Salvador (0.491), which was roughly seven times higher than the lowest *MPK* — Switzerland (0.067). Using the revised estimate of MPK_{CF}, El Salvador still had the most productive capital (0.165), however, an investment in El Salvador was implied to pay a return more than sixteen times the return that could be

earned in Burundi (0.010), which was the country with the second lowest MPK_{CF} (Hong Kong had the lowest MPK_{CF}, estimated to be zero).

FIGURE 2.2 MARGINAL PRODUCTS OF CAPITAL, 1996



Source: (Caselli and Feyrer, 2007)

TABLE 2.4 MARGINAL PRODUCT OF CAPITAL, 1996

	MPK	MPK_{CF}
Mean	0.201	0.074
Standard Deviation	0.105	0.033
Min.	Switzerland : 0.067	Hong Kong : 0.000 Burundi : 0.010
Max.	El Salvador : 0.491	El Salvador : 0.165

Source: (Caselli and Feyrer, 2007)

Caselli and Feyrer's own estimates do not prove the case for marginal products of capital being identical across countries, and subsequently, their findings cannot be used to resolve the Puzzle. Even if marginal products of capital estimated according to Caselli and Feyrer's method were truly identical, it would only neutralise one of the many factors that investors take into consideration when deciding whether to invest domestically or overseas. Caselli and Feyrer's model does not control for differences in political risk, definition and/or protection of property rights, infrastructure for contract

enforcement, and so on across countries. Further, the direction of implied capital flows for countries does not align with Caselli and Feyrer's estimates of these countries' marginal products of capital. All else being equal, a country with a relatively high marginal product of capital should be running a current account deficit. El Salvador, which had both the highest unadjusted and revised marginal products of capital, has run a current account deficit in recent years, but one that is usually less than 5 % of its GDP (The World Bank, 2008). Botswana and Singapore, which had the second highest revised marginal products of capital (0.144) have both run current account surpluses in recent years — usually greater than 5 %, in the case of Botswana, and usually greater than 10 % in the case of Singapore (The World Bank, 2008). Hong Kong, with a 'true' marginal product of capital of zero has run a current account surplus in recent years, however, Burundi (next lowest at 0.010) has run a current account deficit in recent years, as has the Republic of Congo (0.024) (The World Bank, 2008).

Part of this apparent inconsistency between the marginal product of capital and the direction of net capital flows can be attributed to the estimates of *MPK* and MPK_{CF} being representative of a snapshot in time. A country's marginal product of capital may be relatively higher compared to other countries because that country exports capital to the rest of the world for other reasons. There are a number of conditions that can cause this sort of capital flight, such as the lack of coordination across investment projects, poor health in the labour force, insufficient domestic demand for the goods or services being produced, and so on. It is also necessary to consider which sector is actually exporting capital. Economic models are based on a characterisation of the behaviour of a 'representative household', but when there is considerable inequality across households in incomes or wealth, then the behaviour of a country — which reflects the actions of a small percentage of elite households that control a significant share of that country's income and/or wealth — is not representative of the actions of the average household. Even worse is when the observed behaviour of a country is entirely driven by the actions of the executive or the ruling elite, and where money is misappropriated out of a country. Collier (2007) provides examples of this, with banks in the USA having been found 'holding huge deposits from the president of Equatorial Guinea' and banks in London receiving 'massive cash deposits' from the family of a former Nigerian, military dictator. Given the complexities involved, it is no surprise

that the question of why capital does not flow from rich to poor countries, and whether or not international capital markets allocate capital efficiently, is still under debate.

Kraay and Ventura (2000) addressed the Puzzle directly, and analysed differences in the current account balance to GNI ratio across countries, compared to differences in their rates of saving. Regressing the current account to GNI ratio against the rate of saving using the specification in equation (2.17), averaged from 1973-95 for 13 OECD countries,[19] they estimated a coefficient on the rate of saving of $\gamma_1 = 0.23$ (s.e. 0.029) (2000, p. 1140). This gives an indirect confirmation of Feldstein and Horioka's results, since a current account that does not respond to saving implies that most of the variation in saving is captured by the variation in investment. In Kraay and Ventura's model, households were assumed to allocate the marginal unit in the same way as the average unit of saving. Based on this model, they tested the following specification:

$$\left(\frac{CAB}{GNP}\right)_i = \gamma_0 + \gamma_1\left[\left(\frac{S_N}{GNP}\right)_i \bullet \left(\frac{FA}{TA}\right)_i\right] \tag{2.31}$$

The rate of saving was interacted with the proportion that domestically owned foreign assets (FA) made of total domestically owned assets (TA). Estimating this specification gives $\gamma_1 = 0.95$ (s.e. 0.078). This is interpreted to mean that following an income shock, the marginal unit of saving is allocated between foreign and domestic investment in the same way as the average unit of saving. Since Kraay and Ventura use flows of saving and the current account balance that are averaged over a twenty-two year period, the long-term behaviour captured in these averages will be similar to the information contained in the stock of domestically owned foreign assets as a proportion of total domestically owned assets. In addition, Kraay and Ventura use a data set that is once again restricted to the OECD countries — due to data availability — to test a theoretical model of small, open economies. It therefore has limited applicability to the behaviour of developing countries.

[19] The countries included in this study were Australia, Austria, Canada, Germany, Finland, France, Italy, Japan, the Netherlands, Spain, Sweden, the United Kingdom and the United States of America.

2.5 CONCLUSION

The theoretical literature shows that when economies are open and capital movement is unrestricted, investment should flow to wherever it is most profitable, which means that countries' rates of investment need not necessarily be linked to their rates of saving. The theory also implies that capital should flow from capital rich to capital poor countries. Both of these predictions are broadly unsupported by the available data — countries do not leave their current accounts unbalanced unchecked, and capital appears to be flowing from poor countries to rich countries. Outside of the economic growth theory, models of saving allocation and the current account have been developed to rationalise the Puzzle. Two of these models — Sachs', and Obstfeld and Rogoff's — rely on the terms of trade, and the price of imports to motivate a household's desire to keep international financial transactions to a minimum. Caselli and Feyrer's and Lucas' work is based on seeking to demonstrate that countries' marginal products of capital are not so different to one another, when the marginal product of capital is correctly measured. Kraay and Ventura's model assumes that households have allocated their saving between domestic and foreign investment, and that they maintain these proportions as their savings vary. Nevertheless, the summary of the literature on the Puzzle shows that it has weakened over time, which means that in order to test whether the simple saving trap is the primary barrier to growth to today's poor countries, it is necessary to analyse the relationship between these countries' rates of investment and saving.

3 AN EXTENSION OF FELDSTEIN AND HORIOKA

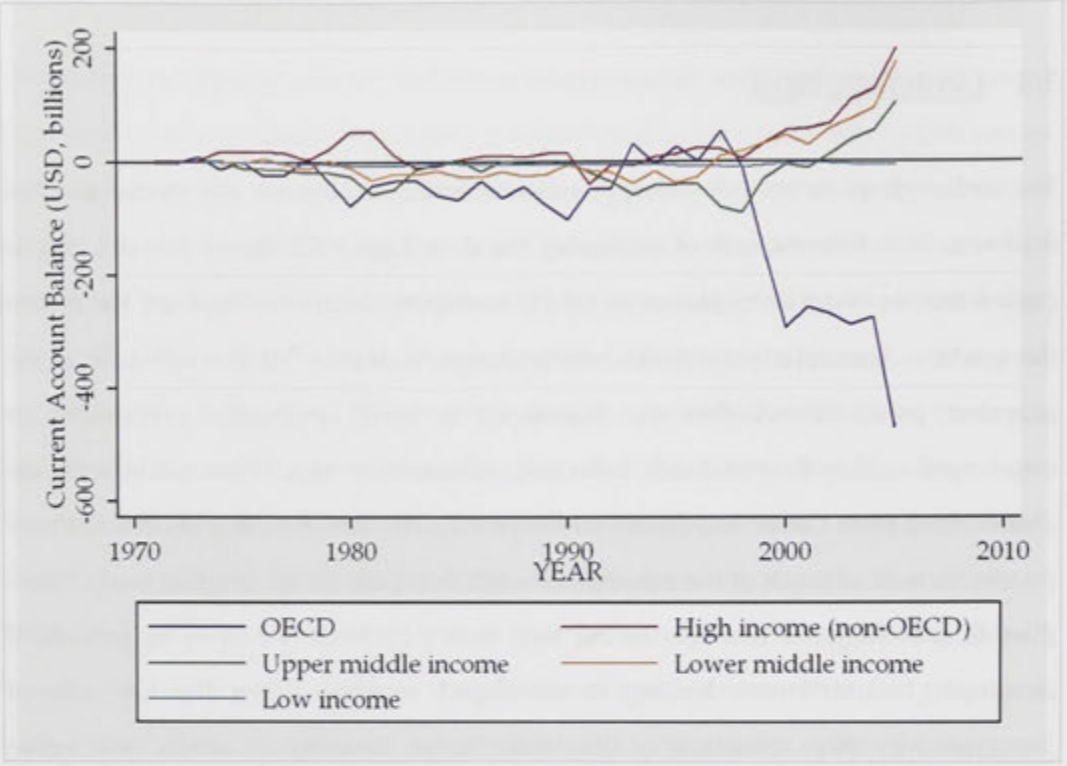
3.1 INTRODUCTION

The earlier chapters set out the apparent contradiction between the theory and the evidence. In a different way of examining the date, Figure 3.1 shows that not only is capital mobile, but that high income OECD countries are borrowing from the rest of the world — particularly the lower middle income countries.[20] It is not clear from the snapshot presented whether the borrowing is used to finance investment or consumption. This flow of funds from poor countries to rich is consistent with the observations from Lucas' and Caselli and Feyrer's work, however, it is at odds with the Puzzle, as well as much of the subsequent work that built on the original study. More than that, it suggests that the saving trap is not by itself a barrier to growth. If developing countries are lending to developed countries, then the low rate of investment in these countries is due more to an inability to attract and retain investment, rather than an inability to forgo consumption by saving.

This chapter examines the relationships between income, investment and saving in developing countries, and presents new evidence on the Puzzle. The first section analyses the relationship between saving, investment and income across countries. The second section extends Feldstein and Horioka's study to analyse the relationship between rates of investment and saving in as many countries as there are data for, and from 1970 to 2005. Finally, the third section summarises and concludes.

[20] Classifications of countries by income is based on the World Bank's 2006 classifications, which define low income countries as those Gross National Income per capita (GNIPC) of $905 or less, lower-middle income countries as those with GNIPC of $906 - $3,595, upper-middle income countries as those with GNIPC of $3,596 - $11,115, and high income countries as those with GNIPC of $11,116 or more.

FIGURE 3.1 CURRENT ACCOUNT BALANCES – SELECTED COUNTRIES



(The World Bank, 2009)

3.2 INCOME AND PRODUCTION EFFECTS

Table 3.1 through to Table 3.4 show the relationships between saving and investment, and income and production, for a cross-section of countries in 1971 and 2000.[21] While the rates of investment and saving are calculated using WDI data,[22] the estimates of GDP and GNI per capita that are shown in Table 3.1 through to Table 3.4 are taken from the Penn World Tables (Heston et al., 2006), details of which are also contained in the appendix to this chapter, so that cross-country comparisons can be made in PPP adjusted terms. Table 3.1 shows that the rate of domestic saving was positively

[21] 1971 is the first year for which data are available for OECD countries in the WDI database. 2000 was the 'benchmark' year for the Penn World Tables version 6.2, and is the year in which data are available for all countries in the database.

[22] As a point of clarification, all 'rates' are implicitly referred to as percentages (i.e., a rate of domestic saving of 30 means that domestic saving accounts for 30 % of GDP) – further details are provided in the appendix to this chapter. The data used to calculate rates of investment and saving are taken from the World Development Indicators (WDI) online database.

correlated with GDP per capita in both 1971 and 2000. Table 3.2 shows that the same is true of the rate of national saving as a proportion of GNI. In addition, the estimated coefficients when the rate of saving is regressed on GDP or GNI are similar to one another in magnitude. Table 3.3 and Table 3.4 show the same for the rate of investment as a proportion of, and plotted against, GDP and GNI per capita respectively.

On average, poorer countries have lower rates of saving and investment than richer countries, validating the hypothesis that simple affordability (or the lack of it) may be part of the barrier to growth faced by poor countries. Table 3.5 shows that the average rate of saving across non-OECD countries (from around 15 to 19 %) has been consistently lower than the average rate of saving across the OECD countries (from around 23 to 28 %). Secondly, the table also shows that, while the average rate of investment was higher across OECD countries than non-OECD countries in 1971, this gap had significantly reduced by 2000, as the average rate of investment across the OECD countries fell from around 28 % to around 22 %.

Rates of saving were strongly positively correlated with income and with production across countries, both in 1971 and in 2000 — although the coefficients on income and on production are much smaller in 2000. Rates of investment, on the other hand, were strongly positively correlated with income and production in 1971, which is consistent with the Puzzle, since the same is true of saving. By 2000, however, not only has the magnitude of the correlation between income/production and investment diminished, but the statistical significance of the coefficient has also fallen. This supports the fact that the Puzzle has weakened in recent years, and that affordability is not as important a driver of rates of investment across countries in 2000 as it was in 1971. It could be argued that investment in physical capital remains low due to scale effects, which in turn is due to limits on affordability, and the inability of poorer countries to make the 'big push' into a modern economy. There is no reason, however, for scale effects to limit the physical capital accumulation of an open economy where capital is freely mobile. If scale effects were the primary barrier to growth, domestic saving should be retained as domestic investment in addition to capital inflows from the rest of the world to make up the difference — the rate of investment would not necessarily be the same as the rate of saving, proving that the saving trap is not the primary barrier to

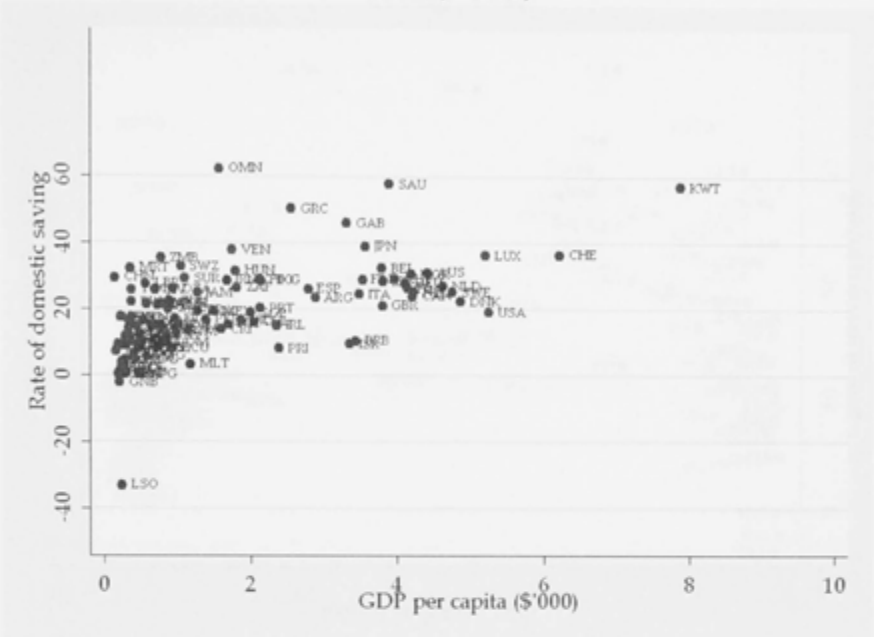
growth. Low rates of investment in countries in 2000 must be due to something more than affordability or scale effects.

Including a squared term in the regressions produces a result that implies that rates of saving and investment rise with income and production up to a point, and then decline, as the coefficient on the squared term is negative in every instance. This is consistent with the evidence from Figure 3.1 that both the poorest countries and the richest countries are borrowing from the rest of the world in order to finance consumption or investment. Nevertheless, it appears that only the very poorest countries have negative rates of saving, and — by implication — are forced to borrow from the rest of the world in order to pay for either consumption, investment or both. There are also far more countries in 2000 that have a negative rate of saving than there were in 1971, which could be attributed in part to the relative ease with which poor countries are now able to borrow from the rest of the world.

Table 3.5 also shows that between 1971 and 2000, the variance of the rate of saving across all countries increased — both for rates of both domestic and national saving — while the variance of both of the rates of investment across the same countries fell over the same period. For the group of OECD countries, the change was even more dramatic. The variance for the rates of saving and investment across countries in 1971 was around 5 for national measures, and 8 for domestic measures. In 2000, both national and domestic rates of saving have roughly the same variances that they did in 1971, however, the variances of the rates of investment across OECD countries has fallen significantly — particularly in the case of the rate of investment as a proportion of GDP. For non-OECD countries, the pattern is the same as for the group of all countries — the variance of the rate of saving across countries increases between 1971 and 2000, while the variance of the rate of investment falls, for the same group of countries and over the same interval of time.

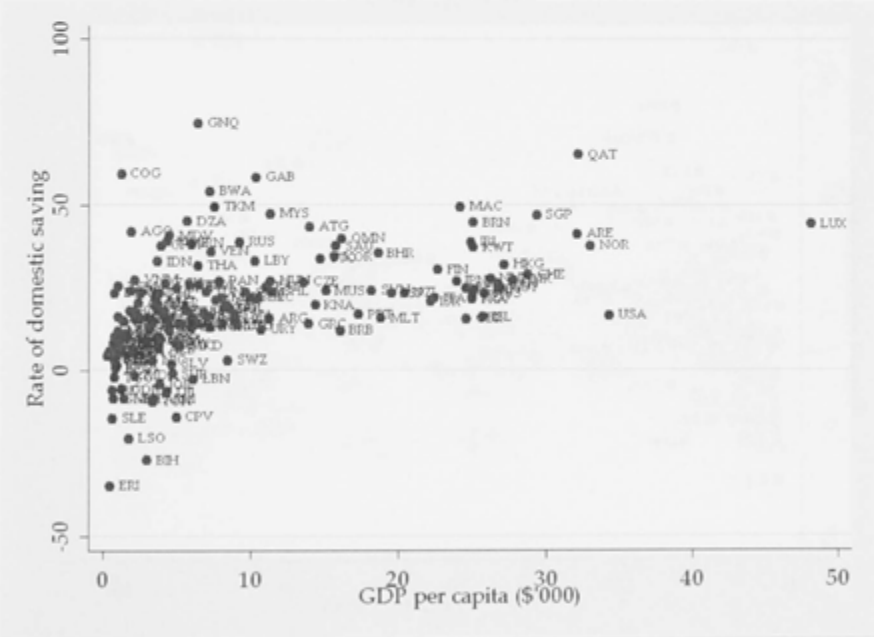
TABLE 3.1 THE RATE OF DOMESTIC SAVING AND GDP PER CAPITA

1971 (n=108)



β_{CGDP}	4.69 (7.16)	6.81 (3.50)
β_{CGDP2}	–	-0.39 (-1.16)

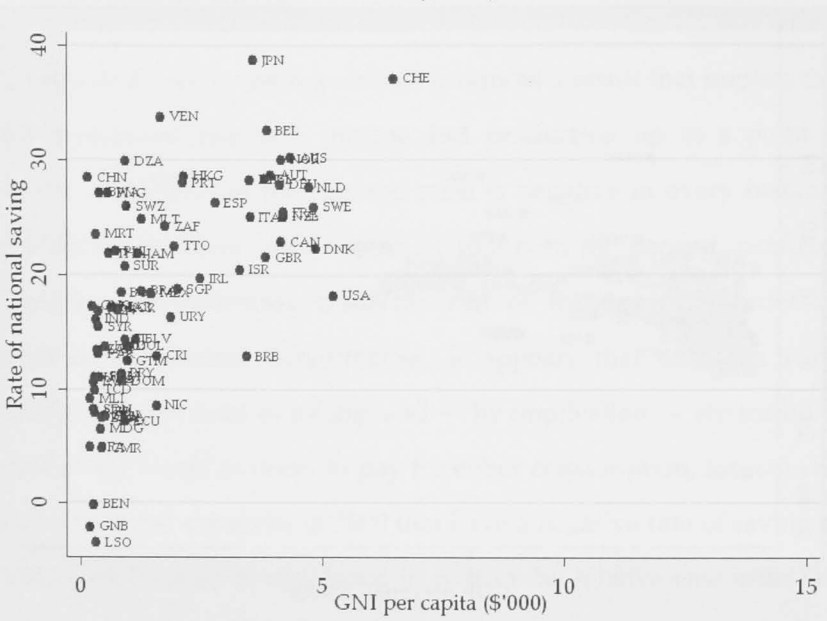
2000 (n=168)



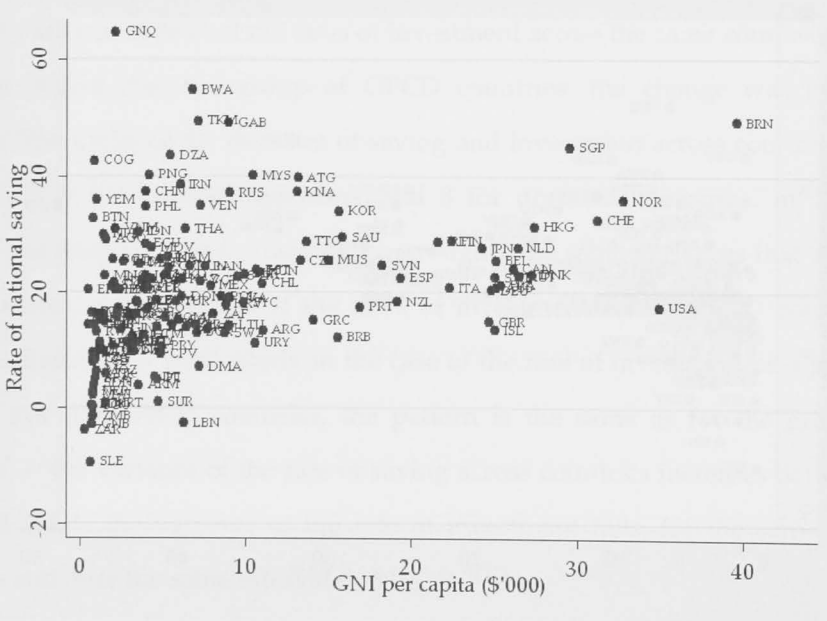
β_{CGDP}	0.84 (7.04)	1.64 (4.65)
β_{CGDP2}	–	-0.03 (-2.39)

Source: (Heston et al., 2006, The World Bank, 2009)
Notes: Numbers in brackets are t-statistics.

TABLE 3.2 THE RATE OF NATIONAL SAVING AND GNI PER CAPITA



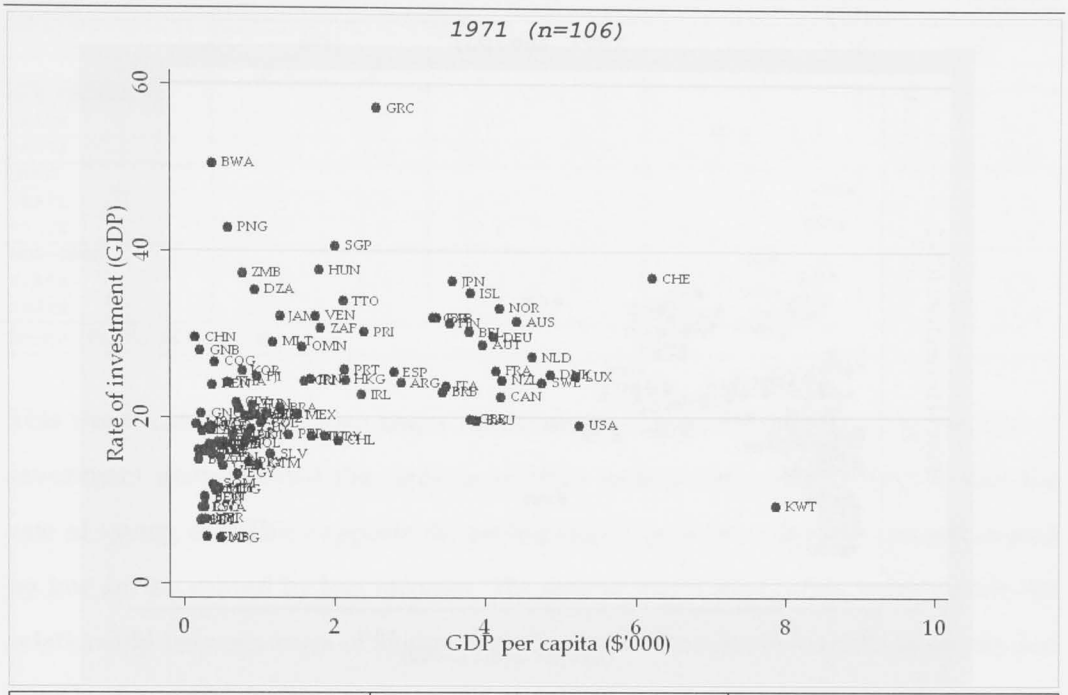
β_{CGNI}	3.55 (6.99)	6.88 (3.72)
β_{CGNI2}	_	-0.67 (-1.87)



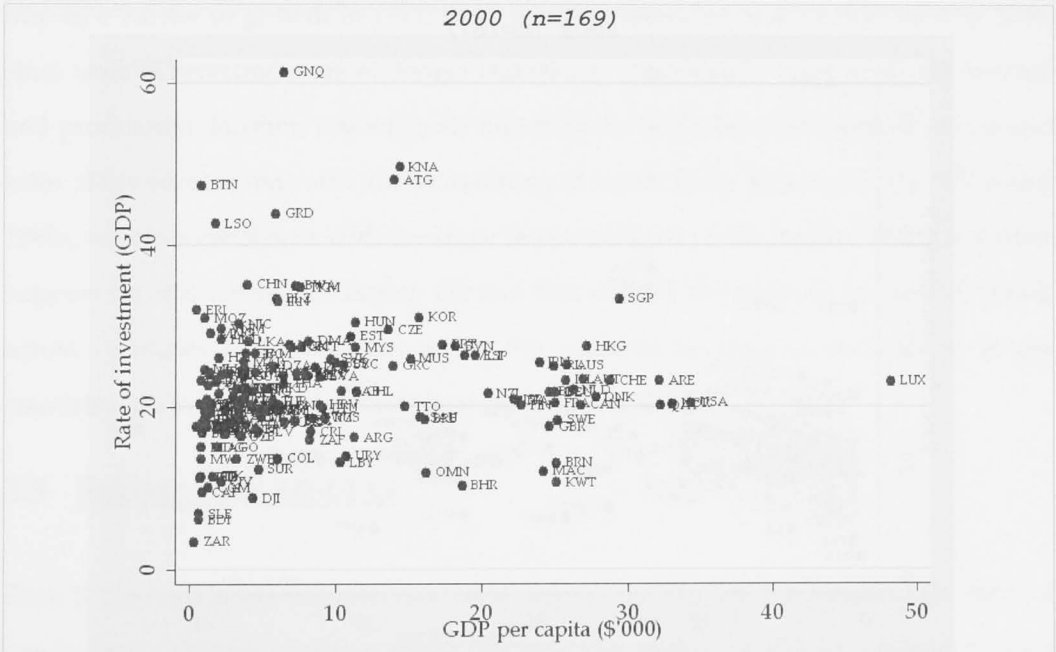
β_{CGNI}	0.47 (4.52)	0.91 (2.63)
β_{CGNI2}	_	-0.01 (-1.32)

Source: (Heston et al., 2006, The World Bank, 2009)
Notes: Numbers in brackets are t-statistics.

TABLE 3.3 THE RATE OF INVESTMENT AND GDP PER CAPITA



β_{CGDP}	1.99 (3.90)	8.07 (5.79)
β_{CGDP2}	–	-1.11 (-4.63)

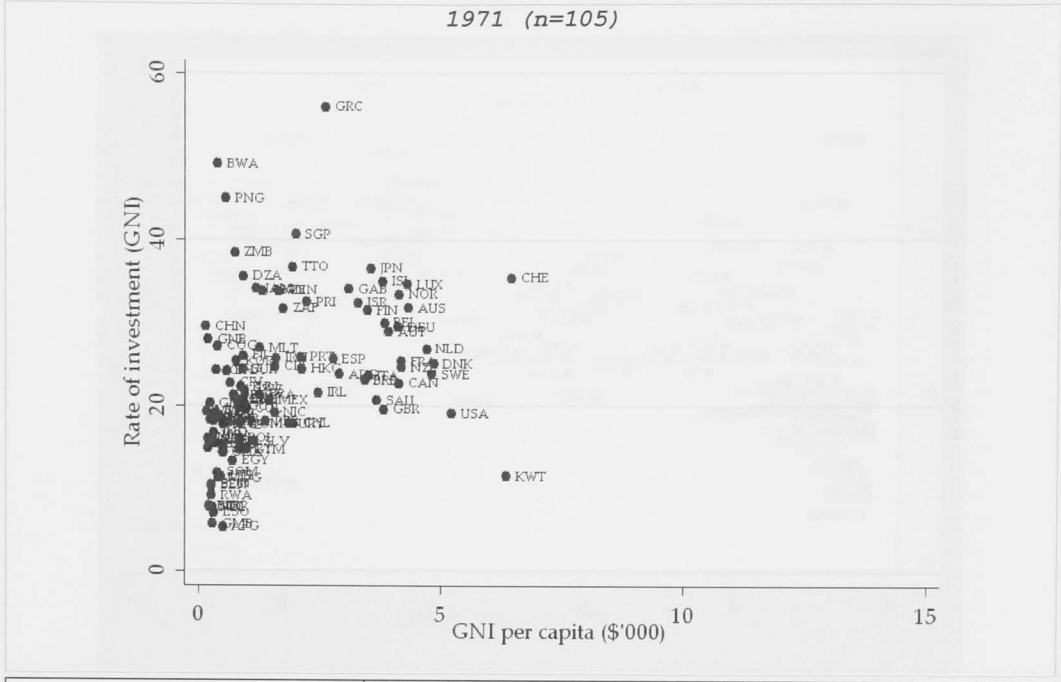


β_{CGDP}	0.06 (0.95)	0.41 (2.16)
β_{CGDP2}	–	-0.01 (-1.95)

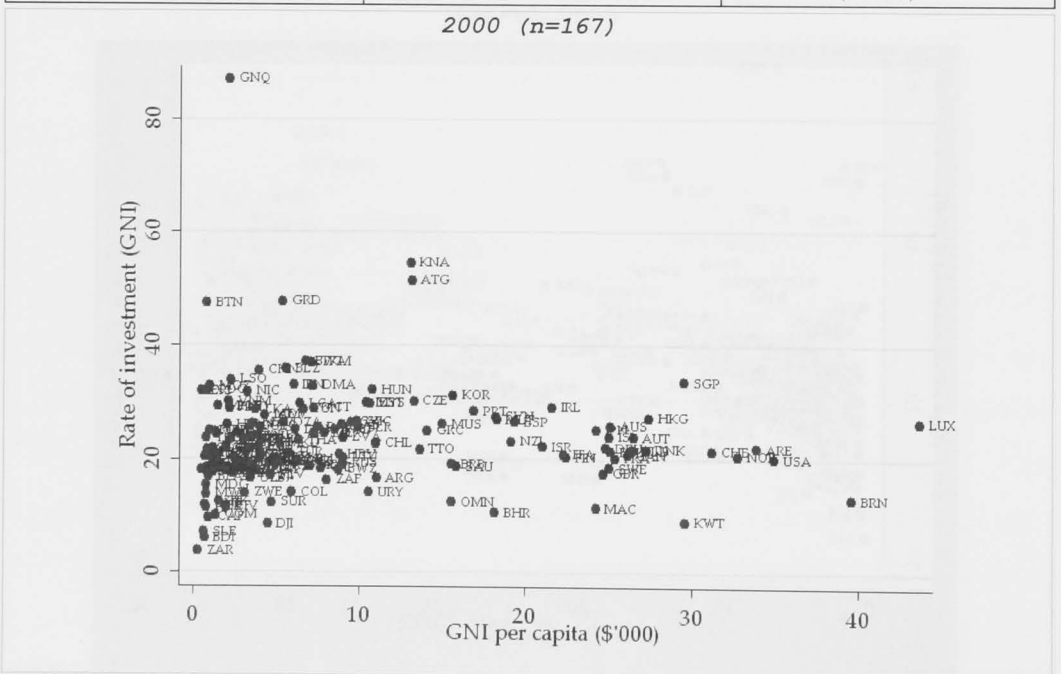
Source: (Heston et al., 2006, The World Bank, 2009)

Notes: Numbers in brackets are t-statistics.

TABLE 3.4 THE RATE OF INVESTMENT AND GNI PER CAPITA



β_{CGNI}	2.27 (4.27)	8.70 (5.05)
β_{CGNI2}	–	-1.27 (-3.90)



β_{CGNI}	0.01 (0.18)	0.46 (1.96)
β_{CGNI2}	–	-0.01 (-2.00)

Source: (Heston et al., 2006, The World Bank, 2009)
Notes: Numbers in brackets are t-statistics.

TABLE 3.5 RATES OF INVESTMENT AND SAVING — SUMMARY STATISTICS

	NATIONAL				DOMESTIC			
	1971		2000		1971		2000	
	μ	σ	μ	σ	μ	σ	μ	σ
ALL COUNTRIES								
IRATE	23.1	8.5	21.7	5.6	22.3	9.2	21.1	6.1
SRATE	18.7	9.4	20.0	10.7	19.2	12.8	19.5	14.2
OECD								
IRATE	27.5	5.1	22.5	3.1	28.7	7.9	22.4	2.6
SRATE	27.1	5.1	23.4	5.6	28.2	7.5	25.0	7.5
NON-OECD								
IRATE	21.2	8.8	21.4	6.4	20.4	8.8	20.8	6.7
SRATE	15.0	8.5	18.6	12.0	16.6	12.8	17.9	15.3

Source: (The World Bank, 2009)

This simple analysis has two major implications. The first is that in 1971, the rate of investment demonstrated the same correlation with income and production that the rate of saving did. This supports the saving trap argument — low investment caused by low saving caused by low incomes. The second major implication is that, while the relationship between rates of saving and income and production across countries has remained roughly similar between 1971 and 2000, they have weakened with respect to rates of investment. This means that while there may have been evidence for a saving trap as a barrier to growth in 1971, there is less evidence to make a case for it in 2000, since rates of investment are no longer statistically significantly correlated with income and production. Further, this suggests that the correlation between rates of saving and rates of investment may also not be as strong in recent years as it was in the 1970s and 1980s, which is consistent with the more recent analysis of the Puzzle. There is further support for this when considering the fact that overall, the variance in rates of saving across countries has increased, while the variance in rates of investment across countries has fallen over the thirty year period.

3.3 ESTIMATION RESULTS

Even if the correlation between countries' rates of saving and investment falls short of one-to-one, a strong, positive correlation indicates that countries on average retain a significant proportion of saving as domestic investment. This thesis analyses the relationship between rates of investment and saving using a model similar to the one specified in equation (2.15), in that only a coefficient on rates of saving and a constant are estimated to explain the variation in the rate of investment across countries. This is done over a thirty-five year period, from 1971 to 2005. Estimates have been obtained

for each year individually, rather than using averages over a period of years. This is because the primary purpose of this analysis is to examine saving retention year by year, rather than whether or not capital is internationally mobile in the long run. Depending on the measure of saving used, data are available for all of the years between 1971 and 2005 for up to 99 countries. Rather than estimating equation (2.15) thirty-five times, the following model is used:

$$\left(\frac{I}{Y}\right)_i = \sum_{t=1971}^{2005} \beta_{0,t} \bullet (YEAR_t) + \sum_{t=1971}^{2005} \beta_{1,t} \bullet \left(YEAR_t \bullet \left(\frac{S}{Y}\right)_i\right) \tag{3.1}$$

Dummy variables ($YEAR_t$) were created for each year in the sample, and these dummies were interacted with the rate of saving. The coefficient estimates and standard errors for $\beta_{0,t}$ and $\beta_{1,t}$ generated in this way are identical to the estimates that would be generated for the same parameters if thirty-five individual cross sections were regressed instead.

Equation (3.1) was used to estimate seventy parameters — thirty-five year dummies, and thirty-five interacted terms — for all countries, all OECD countries, all of the countries in the original Feldstein and Horioka study, all non-OECD countries, and non-OECD, non-oil exporting countries.[23] Further information on the countries in the analysis is provided in the appendix to this chapter, and the numbers of countries included in each group are shown in Table 3.6.

TABLE 3.6 COUNTRIES INCLUDED IN THE ANALYSIS

	DOMESTIC SAVING	NATIONAL SAVING
All Countries	99	68
Feldstein and Horioka sample	16	15
OECD countries	23	21
Non-OECD, non-oil exporting countries	69	44
Non-OECD, oil exporting countries	7	3

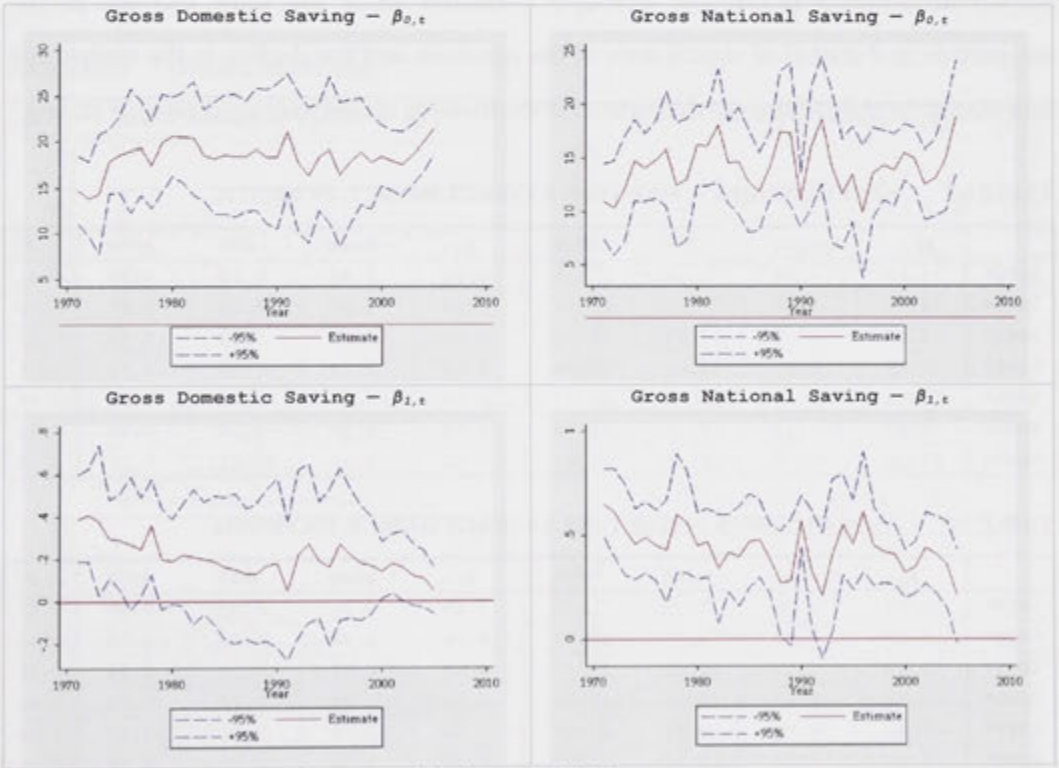
Source: (The World Bank, 2008)

Figure 3.2 summarises the regression output for the group of all countries, showing the change in the estimated constants ($\beta_{0,t}$) and the estimated coefficients ($\beta_{1,t}$) from 1971 to 2005. Results are summarised both for the correlation between the rates of gross

[23] The definition of 'oil exporting countries' for the purposes of this classification is given in the appendix to this chapter.

domestic saving and investment (as proportions of GDP) and rates of gross national saving and investment (as proportions of GNI). As well as the coefficient estimates, the figures in Figure 3.2 also show the maximum and minimum values for the 95 % confidence intervals around the parameter estimates for each year. From this, it is clear that on average, for all of the countries in the sample, rates of gross domestic saving and investment are not statistically significantly correlated with one another over nearly the entirety of the period studied. From 1979 onwards, $\beta_{1,t}$ is not statistically significantly non-zero with the exception of the years 2000 and 2001. The correlation between rates of gross national saving and investment is stronger than for domestic — coefficient estimates are statistically significantly non-zero in all but three years. The coefficients on the rates of saving, however, are never statistically significantly close to one for either national or domestic saving in the period analysed.

FIGURE 3.2 ALL COUNTRIES[24]



Notes: Confidence intervals have been corrected for heteroskedasticity.

[24] Detailed regression output tables, containing the data for all of the charts in this chapter, are in the appendix to this chapter.

There is a decline in the correlation between rates of saving and investment for the group of all countries over time. The estimated coefficient on the rate of domestic saving in 1971 is 0.39 (t = 3.82) — by 2005, it has diminished to just 0.05 (t = 0.88). For the rate of national saving, the decline is from 0.65 (t = 7.67) in 1971 to 0.21 (t = 1.82) in 2005. The movement in the estimated constants for each year are almost precisely the mirror image of the movement in the estimated coefficient on the rate of saving over time. As the variation in the rate of saving explains less and less of the variation in the rate of investment over time, the magnitude and the statistical significance of the constant grows over time. To allow comparison between the estimates for the group of all countries and Feldstein and Horioka's results, the relationship between rates of saving and investment is shown in Table 3.7 and Table 3.8 using five year averages of rates of investment and saving,[26] and the regressions are estimated for every five years from 1971-75 to 2001-05 using the same specification used by Feldstein and Horioka shown in equation (2.15). The averaged estimates show the same increase in the magnitude and statistical significance of the constant, and the decline in the magnitude and statistical significance of the estimated coefficients on the averaged rates of saving.

TABLE 3.7 ALL COUNTRIES — FIVE YEAR AVERAGE IMPACT, DOMESTIC

	$\beta_{0,t}$	t-stat	-95%	+95%	$\beta_{1,t}$	t-stat	-95%	+95%	R^2
1975*	15.89	7.34	11.59	20.19	0.35	2.96	0.12	0.59	0.31
1980*	19.79	7.64	14.65	24.94	0.23	1.89	-0.01	0.47	0.20
1985*	19.53	6.71	13.75	25.31	0.18	1.20	-0.12	0.48	0.13
1990*	18.82	5.18	11.61	26.04	0.14	0.75	-0.23	0.51	0.08
1995*	18.49	4.71	10.70	26.29	0.18	0.93	-0.21	0.58	0.08
2000*	18.06	6.33	12.40	23.72	0.19	1.48	-0.06	0.44	0.14
2005*	19.16	12.65	16.15	22.17	0.12	1.82	-0.01	0.26	0.09

TABLE 3.8 ALL COUNTRIES — FIVE YEAR AVERAGE IMPACT, NATIONAL

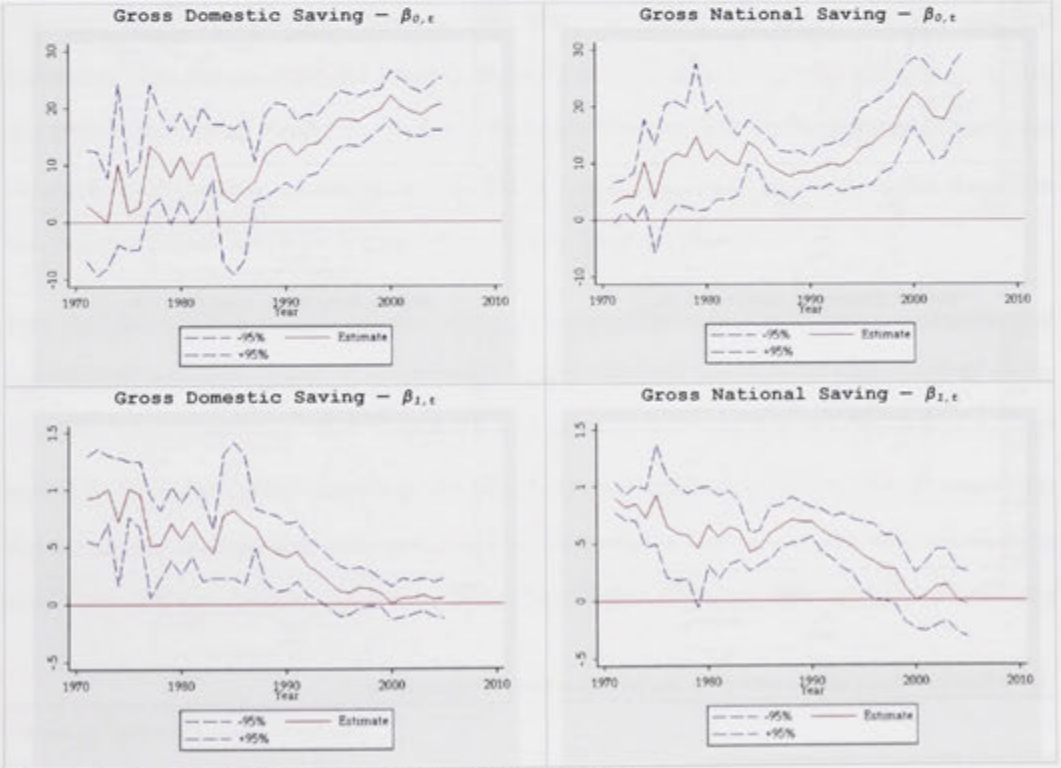
	$\beta_{0,t}$	t-stat	-95%	+95%	$\beta_{1,t}$	t-stat	-95%	+95%	R^2
1975*	11.84	6.08	7.95	15.72	0.58	6.41	0.40	0.76	0.60
1980*	14.02	5.90	9.28	18.77	0.52	4.78	0.30	0.74	0.49
1985*	15.07	6.87	10.69	19.45	0.43	4.07	0.22	0.64	0.38
1990*	13.91	7.37	10.14	17.68	0.42	4.89	0.25	0.59	0.46
1995*	15.41	4.90	9.13	21.68	0.36	2.32	0.05	0.67	0.34
2000*	13.81	8.54	10.58	17.03	0.42	6.08	0.28	0.55	0.41
2005*	14.45	8.49	11.05	17.85	0.37	4.58	0.21	0.53	0.36

Notes: * indicates correction for heteroskedasticity.

[26] Five year averaged impacts on sub-groups of countries are provided in the appendix to this chapter.

This decline in the magnitude and statistical significance of $\beta_{1,t}$ can be attributed to the weakening over time in the relationship between rates of investment and saving in the group of OECD countries (see Figure 3.3). It is implied that in 1971, roughly 90 % (t = 4.92) of domestic saving was retained as investment in OECD countries, falling to only 5 % in 2005 (t = 0.54). The coefficient on rates of domestic saving is statistically significantly close to one, from 1971 to 1986 — overlapping the period studied by Feldstein and Horioka — but by 1995, the coefficient on rates of domestic saving is no longer statistically significantly non-zero. The relationship between rates of gross national saving and investment shows a similar decline, but the estimated coefficients are larger, and statistically significantly non-zero for longer. The estimated constant for both the domestic and national version of the analysis rises over time, mirroring the decline in the coefficient on saving. This validates Feldstein and Horioka's result for the start of the series, but from the mid-1990s and onward it is clear that there is no longer a correlation between rates of investment and saving in OECD countries.

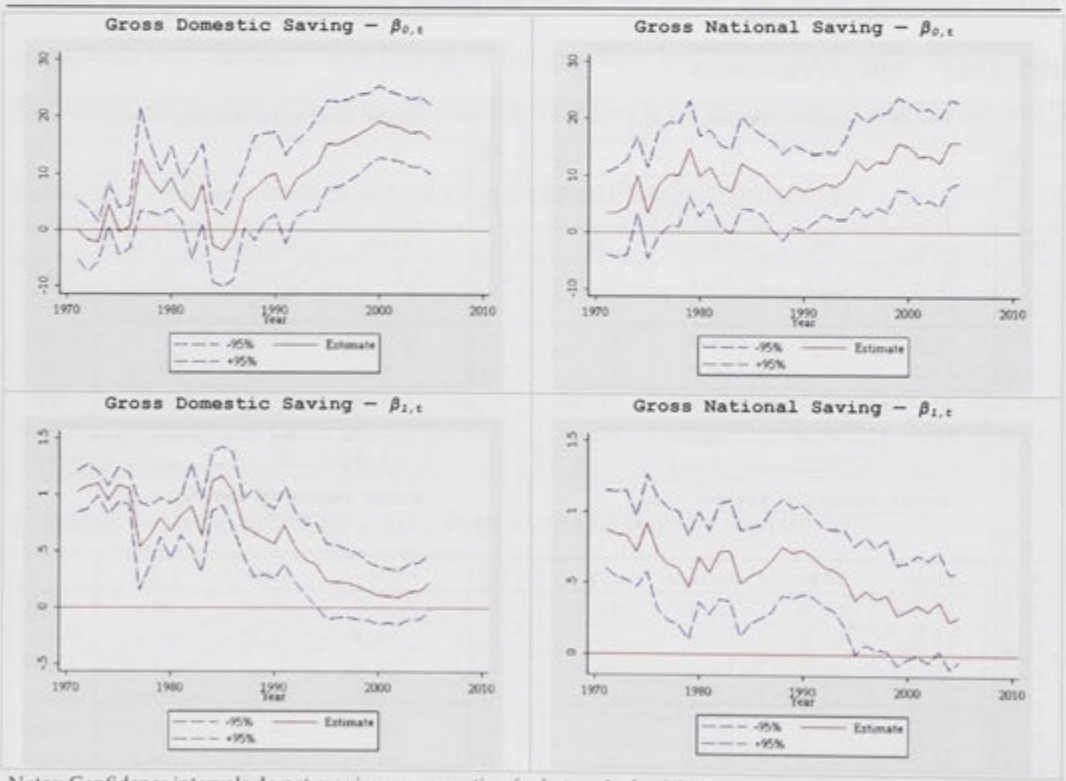
FIGURE 3.3 OECD COUNTRIES



Notes: Confidence intervals have been corrected for heteroskedasticity.

The sample analysed contains twenty-three of the twenty-four OECD countries when analysing domestic saving and investment,[27] and twenty-one of the twenty-four when analysing national saving and investment[28]. Figure 3.4 summarises the estimated constants and coefficients for just the sixteen OECD countries included in the original Feldstein and Horioka study. The coefficient on both the rates of domestic and national saving start out as being statistically significantly close to one in 1971 and this is maintained until around 1990, after which the correlation between rates of investment and saving declines, falling to zero from the mid-1990s onwards. These results are similar to the ones obtained by Helliwell (2004), which were discussed in chapter 2. The decline in the correlation between rates of investment and saving in OECD countries is also captured in the analysis of five-year averages of rates of saving and investment, which is shown in the appendix to this chapter.

FIGURE 3.4 FELDSTEIN AND HORIOKA COUNTRIES



Notes: Confidence intervals do not require any correction for heteroskedasticity.

[27] Turkey does not have the necessary data for all thirty-five years.

[28] Greece, Luxembourg and Turkey do not have the necessary data for all thirty-five years.

The decline in the coefficient on the rate of saving calls into doubt some of the assumptions around the theoretical models developed to explain the Puzzle. The models should still be able to explain the data if the Puzzle no longer applies — as is the case from the mid-1990s and onward. This can be addressed to some extent by acknowledging that as a sub-sample, the OECD countries are not representative of the small economies characterised by the theoretical models. Not only are many of the OECD countries large economies in terms of GDP per capita, but the domestic currencies of many of the OECD countries have historically been in strong demand by much of the rest of the world as reserve currencies.[29] These include the UK's pound sterling, the Japanese yen, the euro (and the Deutsch mark prior to the creation of the euro), and the US dollar. In addition to being the most widely held reserve currency, the US dollar was historically the currency against which the countries that participated in the Bretton Woods system officially linked their currencies to until 1971.

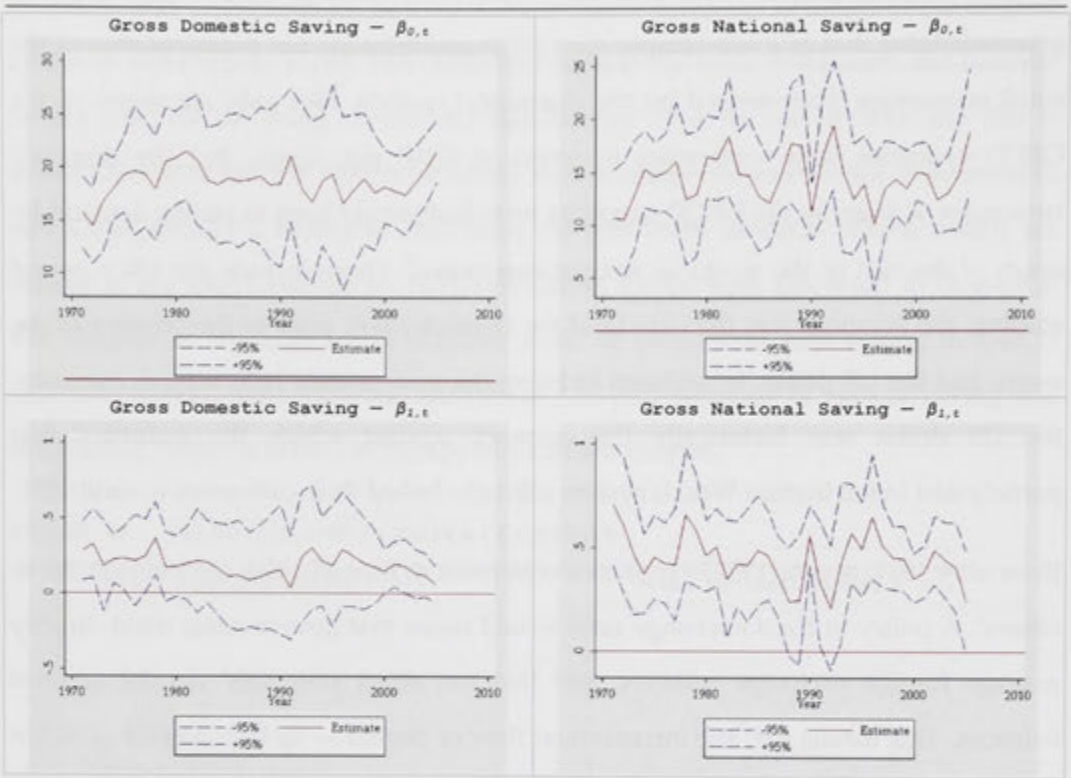
Even after 1971, several OECD countries continued to formally link their currencies to others'. A policy of fixed exchange rates would mean that governments must directly manage foreign exchange reserves, and this can affect countries' current account balances. This means that the international flow of capital — or lack thereof — is not motivated purely by profit maximising investors. In any case, the relationship between rates of investment and saving in developed countries that characterised the Puzzle is no longer evident, and has not been for close to fifteen years.

For the non-OECD countries, the story is very different. As Figure 3.5 shows, the correlation between rates of investment and saving in non-OECD countries is never close to one, implying that developing countries had greater international capital mobility than the OECD countries for the 1970s and 1980s. Unlike the OECD countries, however, the correlation between rates of investment and saving in the developing countries did not decline over time. This means that from the late 1990s onwards, the

[29] All countries that trade internationally hold foreign exchange reserves in order to pay for imports or to accept payment for exports. A reserve currency is one that is in strong demand, and is held in significant amounts by other countries as part of their foreign exchange reserves.

correlation between rates of investment and saving for developing countries was greater than for the OECD countries.

FIGURE 3.5 NON-OECD COUNTRIES



Notes: Confidence intervals have been corrected for heteroskedasticity.

The same is true when oil exporting countries are excluded from the sample, as shown in Figure 3.6. Rather than characterising a puzzle, the higher (but still less than one) coefficient identified in developing countries can be attributed to their having financial and capital markets that are less than perfectly integrated internationally, and that some developing countries peg their currencies to those of other countries' — particularly the US dollar.

FIGURE 3.6 NON-OECD, NON-OIL EXPORTING COUNTRIES

Notes: Confidence intervals have been corrected for heteroskedasticity.

3.4 CONCLUSION

The analysis in this chapter confirmed the findings in recent studies that showed that the close correlation between rates of investment and saving in OECD countries is no longer observed in the most recent data. Not only is the perfect, one-to-one correlation no longer evident, but the coefficient estimates for the most recent years are not even significantly non-zero. Secondly, subsequent studies that included developing and/or non-OECD countries generally found that the estimated coefficients on rates of saving in developing countries were lower than for OECD countries, and therefore lower than the global average. The analysis in this chapter showed that if the sample of non-OECD countries is constant over time, there has been no significant change in the average saving retention for this group of countries over this thirty year period — this is a new finding that has not been discussed in the literature to date. It suggests that the variables that drove the decline in the estimated coefficient for the group of OECD countries — such as improvements in transport technology or reductions in tariffs as suggested by Obstfeld and Rogoff (2001) or the move away from fixed exchange rates

and capital controls in the early 1970s — have not affected the non-OECD countries in the same way. Since the non-OECD countries are not homogenous in the way that the OECD countries arguably are, the reasons for this vary. For example, not all countries shed or reduced capital controls in the 1970s — many of the major Asian economies, for example, still had fixed exchange rates well into the 1990s and China and India continued to maintain strong capital control until relatively recently. Secondly, some non-OECD countries lack financial sophistication, having no central exchange for portfolio capital to be transacted through, or modern financial instruments or accessible financial market information, which means that the knowledge or the ability to meet the expense of international transactions can only be met by a minority elite, rather than the bulk of the population.

Thirdly, this chapter compared the coefficient estimates generated using both gross domestic and gross national saving rates, and found that while the magnitude and the statistical significance of the coefficient estimates is stronger when gross national saving is used, the overall pattern in the value of the estimates over time is roughly the same, regardless of which measure of saving is used. Finally, this chapter demonstrated that the Puzzle does not apply to today's countries regardless of whether they are groups of rich or poor countries. The rate of investment is not solely determined by the rate of saving, although the rate of saving appears to have more influence on the rate of investment in developing than developed countries. This is unsurprising, given that the capital markets of developing countries are more likely to have restrictions than those of the rich countries. In any case, the next question — particularly for the developing countries — is: if the rate of domestic investment is not solely a function of the rate of domestic or national saving, what is it a function of? An alternative model is developed in Chapter 4 and tested in Chapter 5.

3.5 APPENDIX TO CHAPTER 3

As discussed in chapter 2, both domestic and national saving are estimated as residuals — domestic saving is estimated with GDP as the starting point, and national saving with GNI as the starting point. Since it is the same value of final consumption that is subtracted from both to give saving, the difference between national and domestic

saving is the same as the difference between GDP and GNI — the sum of net factor payments to non-residents, and net capital transfers to the rest of the world.

Feldstein and Horioka's analysis looked at the impacts of both domestic and national rates of saving on countries' rates of investment, however, their focus was on domestic saving. The subsequent work by others has focussed on the relationship between rates of national saving and investment, and largely ignored domestic saving. Feldstein and Horioka themselves selected domestic saving as the superior measure, but did not elaborate as to why, only saying that 'the identity of *national* saving and investment does not imply equality of *domestic* saving and investment. Because of international capital flows, domestic saving and investment can differ for long periods of time. For example, during much of the nineteenth century, British domestic saving exceeded domestic investment while Britain invested abroad' (1980, p. 320). This does not establish either national or domestic saving as being superior to the other, since the reasons given for why domestic saving is preferable apply equally to national saving — the existence of international capital flows means that national saving and investment can also vary, even if this was not observed for the countries in the sample at the time.

GDP reflects the country in which income is generated, whereas GNI reflects the country to which that income belongs. As a result, a country's GDP does not necessarily indicate the total funds available for consumption, investment or saving. GDP in that country will be higher than GNI if payments on foreign owned capital are owed, or lower than GNI if aid is received. GNI fully captures the total funds available to a country, however, some of the components of GNI may reflect decisions that have already been made with respect to where to move capital. For example, foreign owned firms have the option of paying dividends to their overseas shareholders, or reinvesting their earnings in the country in which they were generated. If a decision is made to reinvest because the firm believes that there are profitable opportunities for investment in that country, then the domestic saving is retained as investment. If not, then the earnings are either paid out to shareholders, or they may be invested in another country in which the firm operates — effectively, an export of capital. The decision to reinvest earnings or not, depending on the opportunities available to the

foreign firm in the domestic country, should be made using similar criteria to any other investor deciding whether to invest domestically or overseas.

Since neither domestic nor national saving is an unambiguously superior candidate for analysing the relationship between investment and saving, both are used and discussed in this thesis. A related issue that is less problematic is the question of whether to analyse the relationship between gross or net rates of income and saving. This thesis uses gross investment and saving, because using net saving and investment assumes that the value of a country's capital stock that depreciated in a given period is replaced or upgraded out of domestic or national saving, before investment allocation decisions are made about the remainder. Secondly, estimates of depreciation in a country's national accounts are imputed using the perpetual inventory method of capital stock valuation, and generally do not accurately reflect true depreciation. Feldstein and Horioka focussed on gross saving and investment, because they felt that the gross estimates more accurately reflected the saving available to allocate across foreign and domestic investments. They also generated results using net saving and investment, since net investment is a truer reflection of the increase to a country's stock of capital, and noted that the estimated coefficient on the rate of net saving was also close to one (Feldstein and Horioka, 1980).

THE DATA

RATES OF INVESTMENT AND SAVING

Data for estimating the rates of investment and saving used in this chapter are taken from the World Development Indicators online database. Rates of investment and saving are calculated in the following way, where Z indicates the rate, X is the level of saving or investment, and Y is the level of GDP or GNI:

$$Z_{i,t} = 100 \times \left(\frac{X}{Y} \right)_{i,t} \tag{3.2}$$

Different aggregates are substituted for X and Y, to obtain the rates of investment and saving shown in the table.

TABLE 3.9 RATES OF INVESTMENT AND SAVING

Z	X	Y
$SRATE_D$	Gross domestic saving	GDP
$SRATE_N$	Gross national saving	GNI
$IRATE_D$	Gross capital formation	GDP
$IRATE_N$	Gross capital formation	GNI

Notes: The aggregates used are current price values, denominated in the local currency of the individual country.

COUNTRIES INCLUDED IN THE ANALYSIS

These are the sixteen countries that formed the sample in the original Feldstein and Horioka study. They were: ***Australia, Austria, Belgium, Canada, Denmark, Finland, Germany, Greece, Ireland, Italy, Japan, Netherlands, New Zealand, Sweden, United Kingdom,*** and ***United States***. All sixteen countries had data for all of the years between 1971 and 2005 to estimate rates of gross domestic saving and investment as a proportion of GDP. ***Greece*** was the only one of the sixteen that did not have all of the data necessary to estimate rates of gross national saving and investment as a proportion of GNI.

For reasons of data availability and consistency, these other OECD countries were not included in the original Feldstein and Horioka study. ***Turkey*** is the only OECD country that does not have data to calculate rates of gross domestic saving and investment as a proportion of GDP for all of the years from 1971 to 2005. The OECD countries that do are: ***France, Iceland, Luxembourg, Norway, Portugal, Spain,*** and ***Switzerland***. ***Luxembourg*** was the only one of these countries that does not have all of the data necessary to estimate rates of gross national saving and investment as a proportion of GNI.

The classification 'oil exporting countries' is based on whether or not countries were categorised as having fuel as 50 % or more of their total exports between 1988 and 1992. The information for this classification has been the Global Development Network Growth Database (Easterly, 2001). The oil exporting countries that have the necessary data to estimate rates of gross domestic saving and investment as a proportion of GDP for all of the years from 1971 to 2005 are: ***Algeria, Congo (Republic), Gabon, Iran (Islamic Republic), Saudi Arabia, Trinidad and Tobago,*** and ***Venezuela, RB***. Of these seven countries, only ***Algeria, Trinidad and Tobago,*** and ***Venezuela, RB*** have the

necessary data to estimate rates of gross national saving and investment as a proportion of GNI for all of the years from 1971 to 2005.

The classification 'non-OECD countries' is used to categorise all of the countries for which the necessary data are available, and which are also not OECD countries. The non-OECD, non-oil exporting countries that have the necessary data to estimate rates of gross domestic saving and investment as a proportion of GDP for all of the years from 1971 to 2005 are: ***Argentina, Bangladesh, Barbados, Benin, Bolivia, Botswana, Brazil, Burkina Faso, Burundi, Cameroon, Central African Republic, Chile, China, Colombia, Congo (Democratic Republic), Costa Rica, Cote d'Ivoire, Dominican Republic, Ecuador, Egypt, Arab Rep., El Salvador, Fiji, Gambia, Ghana, Guatemala, Guyana, Haiti, Honduras, Hong Kong (China), Hungary, India, Indonesia, Israel, Jamaica, Kenya, Korea, Rep., Kuwait, Lesotho, Madagascar, Malaysia, Mali, Malta, Mauritania, Mexico, Morocco, Nepal, Nicaragua, Niger, Pakistan, Papua New Guinea, Paraguay, Peru, Philippines, Rwanda, Senegal, Singapore, South Africa, Sri Lanka, Sudan, Suriname, Swaziland, Syrian Arab Republic, Thailand, Togo, Tunisia, Uganda, Uruguay, Zambia,*** and ***Zimbabwe***.

The non-OECD, non-oil exporting countries that have the necessary data to estimate rates of gross national saving and investment as a proportion of GNI for all of the years from 1971 to 2005 are: ***Barbados, Benin, Bolivia, Botswana, Brazil, Burkina Faso, Cameroon, China, Colombia, Congo (Democratic Republic), Costa Rica, Dominican Republic, Ecuador, El Salvador, Fiji, Ghana, Guatemala, Guinea-Bissau, Honduras, Hong Kong (China), India, Jamaica, Kenya, Korea (Republic), Lesotho, Madagascar, Mauritania, Mexico, Morocco, Nicaragua, Pakistan, Papua New Guinea, Paraguay, Philippines, Rwanda, Senegal, South Africa, Sri Lanka, Sudan, Swaziland, Syrian Arab Republic, Thailand, Uganda,*** and ***Uruguay***.

INCOME AND PRODUCTION

The data on income and production used in the regressions and the figures in this chapter are taken from the Penn World Tables version 6.2 (Heston et al., 2006). GDP per capita uses the series ***cgdp***, which is denominated in nominal (current), purchasing

power parity adjusted units. From this, GNI is calculated using the series *cgnp* as shown:

(3.3) $$cgni_{i,t} = \frac{cgdp_{i,t} \times cgnp_{i,t}}{100}$$

Both GDP and GNI per capita are divided by 1,000 to give GDP per 1,000 people. This is so that, when they are used in a regression with the rate of investment, the coefficient estimates can be seen within the first two decimal places of the regression output.

DETAILED REGRESSION OUTPUT

ANNUAL IMPACT OF RATES OF SAVING ON RATES OF INVESTMENT

TABLE 3.10 ALL COUNTRIES — RATES OF INVESTMENT AND DOMESTIC SAVING

	n	3465		R^2	0.90		Prob>F	0
	$\beta_{0,t}$	t-stat	-95%	+95%	$\beta_{1,t}$	t-stat	-95%	+95%
1971	14.77	7.79	11.05	18.49	0.65	7.67	0.49	0.82
1972	13.85	6.70	9.80	17.90	0.61	5.78	0.40	0.82
1973	14.30	4.34	7.84	20.75	0.53	4.78	0.31	0.75
1974	17.89	10.04	14.40	21.39	0.46	5.29	0.29	0.63
1975	18.66	8.78	14.49	22.82	0.49	5.68	0.32	0.66
1976	19.05	5.54	12.31	25.80	0.45	5.11	0.28	0.62
1977	19.35	7.43	14.24	24.45	0.43	3.45	0.18	0.67
1978	17.51	7.21	12.75	22.27	0.60	4.22	0.32	0.89
1979	19.87	7.34	14.56	25.18	0.56	4.50	0.32	0.81
1980	20.58	9.29	16.24	24.92	0.45	5.59	0.29	0.61
1981	20.53	8.27	15.66	25.41	0.47	5.53	0.30	0.63
1982	20.43	6.47	14.24	26.63	0.34	2.61	0.08	0.60
1983	18.52	7.33	13.57	23.47	0.42	4.34	0.23	0.60
1984	18.22	5.89	12.15	24.28	0.40	3.33	0.16	0.64
1985	18.65	5.65	12.17	25.12	0.47	4.11	0.25	0.70
1986	18.51	5.40	11.79	25.24	0.48	5.14	0.30	0.67
1987	18.49	6.05	12.49	24.48	0.38	4.42	0.21	0.55
1988	19.18	5.64	12.52	25.84	0.27	2.03	0.01	0.52
1989	18.41	4.93	11.09	25.72	0.28	1.80	-0.03	0.58
1990	18.43	4.56	10.50	26.37	0.57	8.93	0.44	0.69
1991	21.07	6.45	14.66	27.48	0.33	2.30	0.05	0.62
1992	17.77	4.58	10.16	25.38	0.21	1.38	-0.09	0.51
1993	16.38	4.35	8.99	23.77	0.41	2.20	0.04	0.77
1994	18.38	6.14	12.51	24.25	0.55	4.55	0.31	0.79
1995	19.18	4.71	11.19	27.16	0.46	4.10	0.24	0.67
1996	16.44	4.08	8.53	24.34	0.61	4.12	0.32	0.90
1997	17.81	5.14	11.01	24.61	0.45	4.68	0.26	0.64
1998	19.00	6.38	13.16	24.84	0.42	5.73	0.27	0.56
1999	17.86	6.83	12.73	22.98	0.41	5.37	0.26	0.55
2000	18.51	11.14	15.25	21.77	0.32	5.44	0.20	0.43
2001	17.97	10.86	14.72	21.21	0.35	5.36	0.22	0.47
2002	17.57	9.69	14.02	21.13	0.44	5.08	0.27	0.61
2003	18.72	11.30	15.47	21.96	0.41	4.38	0.22	0.59
2004	19.94	12.38	16.78	23.10	0.36	3.36	0.15	0.57
2005	21.51	15.24	18.74	24.28	0.21	1.82	-0.02	0.43

Note: Rates are calculated as a proportion of GDP.
Estimates have been corrected for heteroskedasticity.

TABLE 3.11 ALL COUNTRIES — RATES OF INVESTMENT AND NATIONAL SAVING

	n	2380		R^2	0.95		Prob>F	0
	$\beta_{0,t}$	t-stat	-95%	+95%	$\beta_{1,t}$	t-stat	-95%	+95%
1971	14.77	7.79	11.05	18.49	0.39	3.82	0.19	0.60
1972	13.85	6.70	9.80	17.90	0.41	3.63	0.19	0.63
1973	14.30	4.34	7.84	20.75	0.38	2.12	0.03	0.74
1974	17.89	10.04	14.40	21.39	0.30	3.15	0.11	0.48
1975	18.66	8.78	14.49	22.82	0.29	2.52	0.06	0.51
1976	19.05	5.54	12.31	25.80	0.27	1.69	-0.04	0.59
1977	19.35	7.43	14.24	24.45	0.25	2.08	0.02	0.49
1978	17.51	7.21	12.75	22.27	0.36	3.08	0.13	0.58
1979	19.87	7.34	14.56	25.18	0.20	1.64	-0.04	0.44
1980	20.58	9.29	16.24	24.92	0.19	1.88	-0.01	0.39
1981	20.53	8.27	15.66	25.41	0.22	1.78	-0.02	0.46
1982	20.43	6.47	14.24	26.63	0.21	1.27	-0.11	0.53
1983	18.52	7.33	13.57	23.47	0.20	1.53	-0.06	0.47
1984	18.22	5.89	12.15	24.28	0.19	1.24	-0.11	0.50
1985	18.65	5.65	12.17	25.12	0.16	0.92	-0.18	0.49
1986	18.51	5.40	11.79	25.24	0.15	0.84	-0.20	0.51
1987	18.49	6.05	12.49	24.48	0.13	0.80	-0.18	0.44
1988	19.18	5.64	12.52	25.84	0.13	0.78	-0.20	0.46
1989	18.41	4.93	11.09	25.72	0.17	0.92	-0.19	0.53
1990	18.43	4.56	10.50	26.37	0.18	0.89	-0.22	0.58
1991	21.07	6.45	14.66	27.48	0.05	0.31	-0.28	0.38
1992	17.77	4.58	10.16	25.38	0.22	1.12	-0.17	0.62
1993	16.38	4.35	8.99	23.77	0.27	1.42	-0.10	0.65
1994	18.38	6.14	12.51	24.25	0.19	1.38	-0.08	0.47
1995	19.18	4.71	11.19	27.16	0.16	0.85	-0.21	0.53
1996	16.44	4.08	8.53	24.34	0.27	1.46	-0.09	0.63
1997	17.81	5.14	11.01	24.61	0.22	1.43	-0.08	0.53
1998	19.00	6.38	13.16	24.84	0.18	1.29	-0.09	0.45
1999	17.86	6.83	12.73	22.98	0.17	1.48	-0.06	0.40
2000	18.51	11.14	15.25	21.77	0.14	2.07	0.01	0.28
2001	17.97	10.86	14.72	21.21	0.18	2.50	0.04	0.32
2002	17.57	9.69	14.02	21.13	0.16	1.95	0.00	0.33
2003	18.72	11.30	15.47	21.96	0.12	1.63	-0.02	0.27
2004	19.94	12.38	16.78	23.10	0.11	1.55	-0.03	0.24
2005	21.51	15.24	18.74	24.28	0.05	0.88	-0.06	0.16

Note: Rates are calculated as a proportion of GNI.
Estimates have been corrected for heteroskedasticity.

TABLE 3.12 OECD COUNTRIES – RATES OF INVESTMENT AND DOMESTIC SAVING

	n	805		R^2	0.98		Prob>F	0
	$\beta_{0,t}$	t-stat	-95%	+95%	$\beta_{1,t}$	t-stat	-95%	+95%
1971	2.82	0.57	-6.89	12.54	0.92	4.92	0.55	1.29
1972	1.40	0.25	-9.51	12.31	0.94	4.38	0.52	1.36
1973	-0.19	-0.05	-7.99	7.61	1.01	6.75	0.71	1.30
1974	10.16	1.41	-4.00	24.32	0.72	2.54	0.16	1.28
1975	1.51	0.46	-5.00	8.03	1.01	8.05	0.76	1.25
1976	2.57	0.68	-4.80	9.95	0.96	6.53	0.67	1.25
1977	13.35	2.43	2.55	24.15	0.51	2.22	0.06	0.95
1978	11.57	3.04	4.09	19.06	0.52	3.37	0.22	0.82
1979	7.79	1.88	-0.37	15.94	0.71	4.30	0.38	1.03
1980	11.54	2.96	3.90	19.19	0.57	3.65	0.26	0.88
1981	7.43	1.91	-0.21	15.07	0.72	4.63	0.42	1.03
1982	11.32	2.49	2.39	20.25	0.56	3.05	0.20	0.92
1983	12.24	4.91	7.35	17.14	0.44	4.12	0.23	0.65
1984	4.96	0.80	-7.26	17.18	0.77	2.78	0.23	1.31
1985	3.48	0.54	-9.25	16.22	0.82	2.75	0.23	1.41
1986	5.51	0.88	-6.72	17.74	0.73	2.55	0.17	1.30
1987	7.20	4.13	3.78	10.63	0.66	7.67	0.49	0.83
1988	11.65	3.11	4.30	19.01	0.50	3.20	0.19	0.80
1989	13.26	3.40	5.60	20.92	0.44	2.65	0.11	0.77
1990	13.72	3.97	6.93	20.51	0.41	2.80	0.12	0.70
1991	11.66	3.68	5.45	17.88	0.46	3.48	0.20	0.72
1992	13.48	4.90	8.08	18.88	0.33	2.59	0.08	0.58
1993	13.72	5.27	8.61	18.82	0.27	2.23	0.03	0.50
1994	15.84	6.30	10.90	20.77	0.19	1.72	-0.03	0.41
1995	18.02	6.98	12.95	23.09	0.11	0.97	-0.11	0.33
1996	18.06	7.87	13.55	22.56	0.10	1.03	-0.09	0.30
1997	17.69	7.88	13.28	22.10	0.14	1.66	-0.03	0.32
1998	18.94	8.90	14.76	23.12	0.13	1.68	-0.02	0.28
1999	19.78	11.09	16.27	23.28	0.09	1.49	-0.03	0.21
2000	22.25	10.43	18.06	26.44	0.00	0.06	-0.14	0.15
2001	20.35	8.54	15.68	25.03	0.05	0.58	-0.12	0.22
2002	19.34	8.98	15.11	23.57	0.05	0.71	-0.09	0.20
2003	18.78	9.47	14.89	22.67	0.08	1.18	-0.06	0.22
2004	20.31	9.64	16.17	24.45	0.04	0.55	-0.11	0.19
2005	20.82	8.62	16.07	25.56	0.05	0.54	-0.13	0.22

Note: Rates are calculated as a proportion of GDP.
Estimates have been corrected for heteroskedasticity.

TABLE 3.13 OECD COUNTRIES — RATES OF INVESTMENT AND NATIONAL SAVING

	n	735		R^2	0.99		Prob>F	0
	$\beta_{0,t}$	t-stat	-95%	+95%	$\beta_{1,t}$	t-stat	-95%	+95%
1971	2.97	1.60	-0.67	6.61	0.90	12.90	0.77	1.04
1972	4.19	2.95	1.40	6.99	0.82	14.83	0.71	0.93
1973	4.10	1.87	-0.21	8.41	0.85	10.58	0.70	1.01
1974	10.27	2.68	2.76	17.78	0.73	5.60	0.47	0.98
1975	3.73	0.77	-5.79	13.25	0.93	4.22	0.50	1.37
1976	10.44	2.05	0.43	20.45	0.65	2.83	0.20	1.10
1977	11.78	2.53	2.62	20.94	0.59	2.83	0.18	1.01
1978	11.14	2.49	2.35	19.92	0.57	2.96	0.19	0.94
1979	14.66	2.20	1.60	27.72	0.46	1.73	-0.06	0.99
1980	10.46	2.39	1.86	19.07	0.66	3.70	0.31	1.00
1981	12.34	2.77	3.59	21.10	0.56	2.98	0.19	0.92
1982	10.49	2.99	3.59	17.38	0.64	3.95	0.32	0.96
1983	9.64	3.62	4.41	14.87	0.61	4.73	0.36	0.87
1984	13.76	6.99	9.90	17.63	0.42	5.09	0.26	0.59
1985	12.44	6.66	8.77	16.11	0.47	6.10	0.32	0.62
1986	9.77	4.03	5.00	14.53	0.59	5.16	0.37	0.82
1987	8.54	4.50	4.81	12.26	0.65	6.93	0.47	0.84
1988	7.65	3.51	3.37	11.92	0.71	6.82	0.50	0.91
1989	8.49	4.53	4.81	12.17	0.69	8.06	0.52	0.86
1990	8.40	6.20	5.74	11.05	0.69	10.46	0.56	0.82
1991	9.28	4.81	5.49	13.07	0.61	6.55	0.43	0.80
1992	9.91	5.53	6.39	13.43	0.55	5.78	0.36	0.74
1993	9.43	4.08	4.89	13.97	0.52	4.27	0.28	0.76
1994	10.67	4.11	5.57	15.77	0.47	3.82	0.23	0.71
1995	12.76	3.64	5.88	19.63	0.38	2.40	0.07	0.69
1996	13.40	3.66	6.22	20.59	0.34	2.02	0.01	0.67
1997	15.02	4.39	8.31	21.73	0.28	1.94	0.00	0.57
1998	16.29	4.52	9.21	23.36	0.27	1.72	-0.04	0.57
1999	19.82	5.76	13.07	26.58	0.11	0.71	-0.19	0.40
2000	22.53	7.32	16.49	28.58	0.00	-0.01	-0.25	0.24
2001	20.87	5.54	13.48	28.27	0.04	0.22	-0.27	0.34
2002	18.14	4.66	10.49	25.79	0.12	0.68	-0.22	0.45
2003	17.81	5.27	11.17	24.44	0.13	0.84	-0.18	0.45
2004	21.48	6.54	15.03	27.92	0.00	-0.02	-0.28	0.28
2005	22.98	6.64	16.18	29.78	-0.03	-0.23	-0.32	0.25

Note: Rates are calculated as a proportion of GNI.
Estimates have been corrected for heteroskedasticity.

TABLE 3.14 FELDSTEIN AND HORIOKA SAMPLE COUNTRIES — RATES OF INVESTMENT AND DOMESTIC SAVING

	n	560		R^2	0.99		Prob>F	0
	$\beta_{0,t}$	*t-stat*	*-95%*	*+95%*	$\beta_{1,t}$	*t-stat*	*-95%*	*+95%*
1971	-0.07	-0.02	-5.33	5.19	1.03	11.06	0.84	1.21
1972	-1.92	-0.67	-7.54	3.70	1.07	10.63	0.87	1.27
1973	-2.10	-1.18	-5.62	1.41	1.10	20.07	0.99	1.20
1974	4.48	2.28	0.62	8.34	0.95	14.80	0.82	1.08
1975	-0.27	-0.12	-4.46	3.93	1.08	13.66	0.93	1.24
1976	0.51	0.26	-3.36	4.38	1.05	14.97	0.91	1.19
1977	12.43	2.67	3.28	21.58	0.54	2.74	0.15	0.93
1978	8.94	2.98	3.05	14.83	0.63	4.77	0.37	0.89
1979	6.49	3.27	2.59	10.39	0.80	9.18	0.63	0.97
1980	9.14	3.30	3.69	14.59	0.68	5.45	0.43	0.92
1981	5.35	2.84	1.65	9.06	0.81	9.41	0.64	0.98
1982	3.38	0.78	-5.19	11.95	0.90	4.63	0.52	1.28
1983	8.09	2.29	1.14	15.04	0.63	3.83	0.31	0.96
1984	-2.78	-0.84	-9.27	3.71	1.12	8.36	0.86	1.38
1985	-3.72	-1.15	-10.06	2.62	1.16	8.78	0.90	1.42
1986	-0.97	-0.24	-8.86	6.91	1.03	6.04	0.70	1.37
1987	5.80	2.07	0.30	11.29	0.71	5.60	0.46	0.96
1988	7.32	1.57	-1.87	16.51	0.66	3.35	0.27	1.05
1989	9.23	2.34	1.46	16.99	0.61	3.72	0.29	0.94
1990	10.08	2.74	2.86	17.31	0.56	3.63	0.26	0.87
1991	5.42	1.36	-2.40	13.25	0.73	4.17	0.39	1.07
1992	8.99	2.62	2.24	15.74	0.53	3.36	0.22	0.84
1993	10.29	2.96	3.46	17.13	0.42	2.68	0.11	0.74
1994	11.69	2.77	3.39	19.99	0.38	2.03	0.01	0.75
1995	15.18	3.87	7.47	22.89	0.23	1.40	-0.10	0.57
1996	15.09	3.94	7.57	22.62	0.23	1.40	-0.09	0.55
1997	15.79	4.29	8.55	23.03	0.22	1.43	-0.08	0.52
1998	16.83	4.70	9.79	23.87	0.19	1.28	-0.10	0.48
1999	17.89	5.59	11.60	24.17	0.15	1.11	-0.11	0.40
2000	19.24	6.03	12.97	25.52	0.11	0.84	-0.14	0.36
2001	18.47	6.09	12.51	24.43	0.10	0.83	-0.14	0.34
2002	18.07	6.14	12.29	23.85	0.09	0.74	-0.15	0.33
2003	17.16	5.71	11.26	23.07	0.14	1.15	-0.10	0.39
2004	17.34	5.58	11.23	23.45	0.15	1.17	-0.10	0.40
2005	15.91	5.23	9.93	21.89	0.23	1.83	-0.02	0.48

Note: Rates are calculated as a proportion of GDP.

TABLE 3.15 FELDSTEIN AND HORIOKA SAMPLE COUNTRIES — RATES OF INVESTMENT AND NATIONAL SAVING

	n	525		R^2	0.99		Prob>F	0
	$\beta_{0,t}$	t-stat	-95%	+95%	$\beta_{1,t}$	t-stat	-95%	+95%
1971	3.39	0.92	-3.88	10.67	0.87	6.33	0.60	1.15
1972	3.48	0.86	-4.45	11.40	0.84	5.55	0.54	1.14
1973	4.39	1.03	-4.03	12.82	0.83	5.27	0.52	1.15
1974	9.99	2.98	3.41	16.57	0.72	5.68	0.47	0.96
1975	3.36	0.82	-4.65	11.37	0.92	5.30	0.58	1.26
1976	8.47	1.80	-0.79	17.73	0.71	3.55	0.32	1.10
1977	10.27	2.22	1.17	19.37	0.63	3.16	0.24	1.02
1978	10.14	2.20	1.08	19.21	0.61	2.98	0.21	1.00
1979	14.70	3.45	6.34	23.07	0.47	2.53	0.10	0.83
1980	9.87	2.77	2.86	16.87	0.68	4.24	0.37	1.00
1981	11.56	3.57	5.21	17.92	0.57	3.82	0.28	0.87
1982	8.05	2.23	0.96	15.13	0.72	4.23	0.39	1.06
1983	7.19	1.92	-0.15	14.53	0.72	4.00	0.37	1.08
1984	12.24	2.96	4.10	20.37	0.50	2.62	0.12	0.87
1985	11.10	3.06	3.96	18.23	0.55	3.25	0.22	0.89
1986	10.09	2.84	3.10	17.08	0.58	3.47	0.25	0.91
1987	8.10	2.06	0.35	15.85	0.66	3.60	0.30	1.02
1988	6.18	1.59	-1.44	13.80	0.75	4.38	0.41	1.09
1989	8.15	2.22	0.95	15.36	0.71	4.44	0.40	1.03
1990	7.41	2.08	0.41	14.40	0.74	4.64	0.42	1.05
1991	7.71	2.56	1.78	13.64	0.69	4.76	0.40	0.97
1992	8.72	3.15	3.29	14.15	0.62	4.46	0.34	0.89
1993	8.12	2.74	2.30	13.94	0.59	4.05	0.31	0.88
1994	9.45	2.62	2.35	16.55	0.53	3.10	0.20	0.87
1995	12.82	3.05	4.55	21.10	0.38	1.98	0.00	0.76
1996	11.09	2.65	2.86	19.32	0.45	2.33	0.07	0.83
1997	12.55	3.03	4.42	20.68	0.39	2.16	0.03	0.75
1998	12.33	2.77	3.57	21.09	0.42	2.13	0.03	0.81
1999	15.55	3.80	7.51	23.60	0.28	1.55	-0.08	0.63
2000	15.04	3.78	7.21	22.87	0.31	1.80	-0.03	0.65
2001	13.32	3.23	5.20	21.43	0.35	1.93	-0.01	0.70
2002	13.69	3.36	5.69	21.69	0.30	1.66	-0.06	0.66
2003	12.36	3.13	4.60	20.11	0.38	2.12	0.03	0.73
2004	15.72	4.13	8.24	23.20	0.24	1.41	-0.09	0.57
2005	15.70	4.41	8.70	22.70	0.27	1.68	-0.05	0.58

Note: Rates are calculated as a proportion of GNI.

TABLE 3.16 NON-OECD COUNTRIES – RATES OF INVESTMENT AND DOMESTIC SAVING

	n	2660		R^2	0.89		Prob>F	0
	$\beta_{0,t}$	t-stat	-95%	+95%	$\beta_{1,t}$	t-stat	-95%	+95%
1971	15.77	9.28	12.44	19.10	0.28	2.82	0.09	0.48
1972	14.52	7.92	10.93	18.11	0.33	2.82	0.10	0.56
1973	16.77	7.07	12.12	21.42	0.18	1.19	-0.12	0.48
1974	17.96	12.03	15.04	20.89	0.23	2.80	0.07	0.38
1975	19.32	10.59	15.74	22.90	0.23	2.16	0.02	0.44
1976	19.69	6.37	13.63	25.76	0.21	1.40	-0.09	0.52
1977	19.42	7.53	14.37	24.47	0.25	2.00	0.00	0.49
1978	17.99	7.21	13.10	22.88	0.37	2.97	0.12	0.61
1979	20.60	8.08	15.60	25.59	0.17	1.46	-0.06	0.40
1980	20.91	9.40	16.55	25.27	0.18	1.72	-0.02	0.38
1981	21.59	9.13	16.95	26.22	0.20	1.60	-0.04	0.44
1982	20.74	6.60	14.58	26.89	0.21	1.22	-0.13	0.56
1983	18.80	7.47	13.87	23.73	0.21	1.47	-0.07	0.48
1984	18.44	6.43	12.81	24.07	0.16	1.03	-0.14	0.46
1985	19.03	6.19	13.00	25.06	0.12	0.67	-0.22	0.45
1986	18.79	5.83	12.46	25.11	0.12	0.63	-0.25	0.48
1987	18.89	6.56	13.25	24.53	0.09	0.56	-0.22	0.40
1988	19.23	5.87	12.81	25.65	0.11	0.61	-0.24	0.45
1989	18.45	5.09	11.34	25.56	0.14	0.71	-0.24	0.51
1990	18.55	4.60	10.64	26.46	0.16	0.72	-0.27	0.59
1991	21.24	6.66	14.98	27.50	0.04	0.21	-0.31	0.38
1992	18.09	4.48	10.18	26.01	0.24	1.09	-0.19	0.68
1993	16.78	4.29	9.11	24.46	0.30	1.43	-0.11	0.72
1994	18.80	6.05	12.71	24.89	0.21	1.43	-0.08	0.51
1995	19.45	4.55	11.07	27.82	0.18	0.90	-0.22	0.59
1996	16.68	4.00	8.51	24.85	0.29	1.51	-0.09	0.67
1997	17.96	4.92	10.81	25.11	0.25	1.47	-0.08	0.59
1998	19.04	6.05	12.87	25.21	0.20	1.28	-0.11	0.51
1999	17.74	6.34	12.26	23.22	0.18	1.38	-0.08	0.43
2000	18.30	10.39	14.84	21.75	0.15	1.98	0.00	0.30
2001	17.88	10.22	14.45	21.31	0.20	2.51	0.04	0.35
2002	17.52	9.12	13.75	21.29	0.18	1.96	0.00	0.36
2003	18.79	10.79	15.38	22.21	0.13	1.62	-0.03	0.30
2004	20.06	11.82	16.73	23.39	0.12	1.62	-0.02	0.27
2005	21.66	14.53	18.74	24.58	0.06	0.90	-0.07	0.18

Note: Rates are calculated as a proportion of GDP.
Estimates have been corrected for heteroskedasticity.

TABLE 3.17 NON-OECD COUNTRIES — RATES OF INVESTMENT AND NATIONAL SAVING

	n	1645		R^2	0.93		Prob>F	0
	$\beta_{0,t}$	t-stat	-95%	+95%	$\beta_{1,t}$	t-stat	-95%	+95%
1971	10.69	4.62	6.15	15.24	0.70	4.70	0.41	1.00
1972	10.55	3.78	5.07	16.04	0.61	3.65	0.28	0.93
1973	12.80	4.85	7.62	17.97	0.46	3.15	0.18	0.75
1974	15.29	8.20	11.64	18.95	0.37	3.83	0.18	0.56
1975	14.61	8.87	11.38	17.84	0.45	4.41	0.25	0.65
1976	15.04	7.91	11.32	18.77	0.42	4.27	0.23	0.62
1977	16.00	5.59	10.39	21.62	0.42	3.05	0.15	0.69
1978	12.43	3.94	6.25	18.61	0.66	4.06	0.34	0.98
1979	12.94	4.27	7.00	18.88	0.58	4.27	0.32	0.85
1980	16.44	8.21	12.51	20.38	0.46	5.21	0.29	0.63
1981	16.25	8.27	12.40	20.11	0.50	5.33	0.32	0.69
1982	18.40	6.51	12.86	23.94	0.35	2.42	0.07	0.63
1983	14.81	7.21	10.78	18.84	0.42	3.97	0.21	0.63
1984	14.67	5.35	9.29	20.04	0.42	2.97	0.14	0.69
1985	12.72	4.82	7.54	17.89	0.48	3.58	0.22	0.75
1986	12.07	6.03	8.14	16.00	0.46	4.24	0.25	0.68
1987	14.59	8.85	11.35	17.82	0.35	3.52	0.16	0.55
1988	17.70	6.16	12.06	23.33	0.24	1.79	-0.02	0.50
1989	17.48	5.11	10.77	24.19	0.25	1.53	-0.07	0.56
1990	11.28	8.25	8.60	13.96	0.55	7.53	0.41	0.70
1991	16.41	5.53	10.59	22.22	0.33	2.16	0.03	0.63
1992	19.39	6.30	13.35	25.43	0.21	1.36	-0.09	0.51
1993	14.92	3.92	7.45	22.39	0.43	2.18	0.04	0.81
1994	12.48	4.66	7.22	17.73	0.57	4.68	0.33	0.81
1995	13.81	5.91	9.23	18.40	0.49	4.23	0.26	0.72
1996	10.13	3.15	3.81	16.44	0.65	4.28	0.35	0.95
1997	13.45	5.84	8.93	17.96	0.51	4.95	0.31	0.71
1998	14.33	8.35	10.97	17.70	0.45	5.82	0.30	0.60
1999	13.44	7.44	9.89	16.98	0.45	5.61	0.29	0.60
2000	15.00	10.89	12.30	17.71	0.35	5.82	0.23	0.47
2001	14.79	9.79	11.83	17.76	0.38	5.90	0.26	0.51
2002	12.35	7.75	9.22	15.47	0.49	5.82	0.32	0.65
2003	13.10	7.16	9.51	16.69	0.44	4.72	0.26	0.62
2004	14.75	5.56	9.55	19.95	0.41	3.72	0.19	0.62
2005	18.79	6.18	12.82	24.75	0.24	1.94	0.00	0.48

Note: Rates are calculated as a proportion of GNI.
Estimates have been corrected for heteroskedasticity.

TABLE 3.18 NON-OECD, NON OIL EXPORTING COUNTRIES — RATES OF INVESTMENT AND DOMESTIC SAVING

	n	2415		R^2	0.89		Prob>F	0
	$\beta_{0,t}$	t-stat	-95%	+95%	$\beta_{1,t}$	t-stat	-95%	+95%
1971	15.18	7.89	11.41	18.95	0.30	2.28	0.04	0.55
1972	14.01	7.33	10.26	17.76	0.32	2.47	0.07	0.57
1973	14.75	7.80	11.04	18.45	0.30	2.57	0.07	0.52
1974	18.12	10.96	14.88	21.36	0.20	1.94	0.00	0.41
1975	19.33	11.85	16.13	22.52	0.19	1.91	-0.01	0.38
1976	20.57	8.51	15.83	25.31	0.10	0.77	-0.15	0.35
1977	20.06	9.97	16.12	24.01	0.15	1.57	-0.04	0.35
1978	18.22	7.36	13.36	23.08	0.32	2.40	0.06	0.58
1979	20.83	8.35	15.94	25.73	0.14	1.12	-0.11	0.39
1980	20.67	8.25	15.75	25.58	0.18	1.31	-0.09	0.45
1981	21.47	8.32	16.41	26.53	0.19	1.19	-0.12	0.49
1982	21.36	7.33	15.65	27.08	0.13	0.69	-0.23	0.48
1983	18.99	8.43	14.57	23.40	0.15	1.10	-0.12	0.43
1984	18.51	6.83	13.19	23.82	0.12	0.74	-0.20	0.44
1985	19.40	6.97	13.94	24.86	0.06	0.34	-0.27	0.38
1986	18.64	6.07	12.62	24.66	0.09	0.48	-0.26	0.44
1987	18.87	6.68	13.33	24.40	0.08	0.50	-0.23	0.39
1988	19.36	6.07	13.11	25.61	0.09	0.50	-0.25	0.42
1989	18.44	4.98	11.18	25.70	0.15	0.73	-0.25	0.54
1990	18.53	4.42	10.32	26.75	0.18	0.73	-0.30	0.65
1991	21.32	7.01	15.36	27.29	0.00	0.03	-0.35	0.36
1992	18.31	4.53	10.38	26.24	0.22	0.92	-0.25	0.68
1993	16.87	4.24	9.07	24.66	0.30	1.31	-0.15	0.75
1994	18.55	5.63	12.09	25.01	0.25	1.45	-0.09	0.58
1995	19.46	4.27	10.52	28.41	0.19	0.77	-0.29	0.66
1996	16.48	3.66	7.66	25.30	0.33	1.39	-0.14	0.79
1997	17.89	4.38	9.88	25.90	0.26	1.19	-0.17	0.68
1998	19.40	6.35	13.41	25.39	0.14	0.88	-0.17	0.46
1999	17.98	5.95	12.06	23.91	0.15	0.96	-0.16	0.46
2000	17.94	8.76	13.92	21.96	0.18	1.73	-0.02	0.38
2001	17.86	9.06	14.00	21.73	0.19	1.82	-0.02	0.40
2002	17.61	8.14	13.37	21.86	0.17	1.39	-0.07	0.41
2003	18.97	9.54	15.07	22.87	0.12	1.04	-0.10	0.34
2004	20.04	10.40	16.26	23.83	0.12	1.22	-0.08	0.32
2005	21.52	12.54	18.15	24.88	0.07	0.79	-0.10	0.25

Note: Rates are calculated as a proportion of GDP.
Estimates have been corrected for heteroskedasticity.

TABLE 3.19 NON-OECD, NON OIL EXPORTING COUNTRIES — RATES OF INVESTMENT AND NATIONAL SAVING

	n	1540		R^2	0.93		Prob>F	0
	$\beta_{0,t}$	t-stat	-95%	+95%	$\beta_{1,t}$	t-stat	-95%	+95%
1971	11.10	4.26	5.99	16.20	0.65	3.51	0.29	1.02
1972	11.03	3.65	5.10	16.96	0.55	2.77	0.16	0.93
1973	13.55	5.04	8.28	18.82	0.40	2.40	0.07	0.72
1974	15.27	7.35	11.20	19.35	0.37	3.11	0.14	0.61
1975	15.16	8.60	11.71	18.62	0.40	3.54	0.18	0.63
1976	16.02	9.12	12.58	19.46	0.34	3.85	0.17	0.52
1977	17.76	6.81	12.64	22.87	0.28	2.41	0.05	0.50
1978	13.80	4.68	8.02	19.58	0.55	3.50	0.24	0.85
1979	13.45	4.32	7.34	19.56	0.54	3.61	0.25	0.84
1980	16.46	7.73	12.28	20.64	0.46	4.38	0.26	0.67
1981	15.93	7.54	11.78	20.08	0.54	4.83	0.32	0.76
1982	18.70	6.53	13.08	24.32	0.31	2.02	0.01	0.60
1983	15.21	7.29	11.12	19.29	0.39	3.56	0.17	0.60
1984	14.95	5.36	9.48	20.42	0.39	2.67	0.10	0.67
1985	13.07	4.90	7.83	18.31	0.46	3.30	0.19	0.73
1986	11.93	5.87	7.94	15.92	0.45	4.08	0.23	0.66
1987	14.54	8.84	11.31	17.76	0.34	3.40	0.14	0.54
1988	17.69	6.11	12.01	23.38	0.23	1.74	-0.03	0.49
1989	17.57	5.11	10.82	24.32	0.25	1.53	-0.07	0.56
1990	11.17	8.27	8.52	13.82	0.59	9.02	0.46	0.72
1991	16.62	5.62	10.82	22.42	0.32	2.05	0.01	0.63
1992	19.54	6.44	13.58	25.50	0.20	1.30	-0.10	0.50
1993	15.09	3.93	7.57	22.62	0.42	2.13	0.03	0.81
1994	12.65	4.74	7.41	17.89	0.57	4.70	0.33	0.81
1995	13.84	5.87	9.21	18.46	0.50	4.16	0.26	0.73
1996	9.89	3.13	3.70	16.09	0.69	4.48	0.39	0.99
1997	13.12	5.53	8.47	17.77	0.53	4.80	0.31	0.74
1998	14.40	8.31	11.01	17.80	0.42	5.46	0.27	0.57
1999	13.53	7.42	9.95	17.11	0.44	5.21	0.27	0.60
2000	14.65	10.50	11.91	17.39	0.39	5.84	0.26	0.51
2001	14.72	9.35	11.63	17.80	0.39	5.30	0.24	0.53
2002	12.19	7.28	8.90	15.47	0.50	5.38	0.32	0.69
2003	12.53	6.41	8.70	16.37	0.48	4.66	0.28	0.69
2004	14.15	5.00	8.60	19.71	0.45	3.76	0.22	0.69
2005	18.16	5.21	11.33	25.00	0.29	1.92	-0.01	0.58

Note: Rates are calculated as a proportion of GNI.
Estimates have been corrected for heteroskedasticity.

LONG RUN IMPACT OF RATES OF SAVING ON RATES OF INVESTMENT

TABLE 3.20 OECD COUNTRIES — LONG RUN IMPACT OF DOMESTIC SAVING ON INVESTMENT

	$\beta_{0,t}$	t-stat	-95%	+95%	$\beta_{1,t}$	t-stat	-95%	+95%	R^2
1975*	2.94	0.58	-7.61	13.49	0.93	4.67	0.51	1.34	0.74
1980	16.63	4.14	8.27	24.99	0.35	2.10	0.00	0.70	0.13
1985	13.88	3.95	6.57	21.19	0.41	2.70	0.09	0.72	0.22
1990*	12.14	3.24	4.35	19.93	0.47	2.88	0.13	0.80	0.43
1995*	14.88	5.12	8.84	20.93	0.26	1.99	-0.01	0.52	0.22
2000*	19.54	10.32	15.61	23.48	0.09	1.27	-0.05	0.23	0.05
2005*	19.89	9.82	15.68	24.11	0.06	0.78	-0.09	0.21	0.02

TABLE 3.21 OECD COUNTRIES — LONG RUN IMPACT OF NATIONAL SAVING ON INVESTMENT

	$\beta_{0,t}$	t-stat	-95%	+95%	$\beta_{1,t}$	t-stat	-95%	+95%	R^2
1975*	4.51	2.18	0.19	8.84	0.87	10.32	0.69	1.04	0.76
1980	10.97	3.08	3.52	18.42	0.62	4.13	0.30	0.93	0.45
1985	12.23	3.94	5.74	18.73	0.52	3.69	0.22	0.81	0.39
1990*	8.54	5.55	5.32	11.76	0.67	8.74	0.51	0.83	0.73
1995*	9.90	4.24	5.02	14.78	0.53	4.52	0.28	0.77	0.58
2000	17.70	5.49	10.95	24.45	0.18	1.31	-0.11	0.48	0.03
2005	20.25	5.82	12.97	27.52	0.05	0.33	-0.27	0.37	-0.05

TABLE 3.22 FELDSTEIN AND HORIOKA SAMPLE COUNTRIES — LONG RUN IMPACT OF DOMESTIC SAVING ON INVESTMENT

	$\beta_{0,t}$	t-stat	-95%	+95%	$\beta_{1,t}$	t-stat	-95%	+95%	R^2
1975	-0.30	-0.13	-5.09	4.50	1.06	13.87	0.89	1.22	0.93
1980*	13.84	2.43	1.61	26.07	0.47	1.99	-0.04	0.98	0.41
1985	7.07	1.66	-2.06	16.19	0.71	3.76	0.31	1.12	0.47
1990*	8.70	2.08	-0.28	17.68	0.61	3.50	0.24	0.98	0.54
1995*	10.72	1.83	-1.87	23.31	0.44	1.63	-0.14	1.02	0.30
2000	17.43	6.10	11.30	23.56	0.16	1.33	-0.10	0.41	0.05
2005*	17.40	6.26	11.43	23.36	0.14	1.38	-0.08	0.37	0.11

TABLE 3.23 FELDSTEIN AND HORIOKA SAMPLE COUNTRIES — LONG RUN IMPACT OF NATIONAL SAVING ON INVESTMENT

	$\beta_{0,t}$	t-stat	-95%	+95%	$\beta_{1,t}$	t-stat	-95%	+95%	R^2
1975	4.74	1.62	-1.57	11.04	0.84	7.52	0.60	1.09	0.80
1980*	10.34	2.25	0.41	20.28	0.63	3.40	0.23	1.04	0.56
1985*	10.19	2.67	1.94	18.44	0.61	3.57	0.24	0.97	0.46
1990*	8.03	6.19	5.23	10.84	0.69	9.72	0.54	0.84	0.71
1995*	8.54	3.59	3.41	13.68	0.60	4.91	0.34	0.86	0.65
2000	13.52	3.37	4.85	22.20	0.36	2.02	-0.02	0.74	0.18
2005*	13.88	3.10	4.22	23.54	0.32	1.52	-0.13	0.77	0.15

Notes: * indicates correction for heteroskedasticity.

TABLE 3.24 NON-OECD COUNTRIES — LONG RUN IMPACT OF DOMESTIC SAVING ON INVESTMENT

	$\beta_{0,t}$	t-stat	-95%	+95%	$\beta_{1,t}$	t-stat	-95%	+95%	R^2
1975*	16.77	9.82	13.37	20.17	0.25	2.41	0.04	0.46	0.21
1980*	19.88	7.64	14.70	25.07	0.23	1.82	-0.02	0.47	0.20
1985*	19.69	6.82	13.94	25.43	0.18	1.13	-0.14	0.50	0.13
1990*	18.93	5.38	11.92	25.95	0.11	0.58	-0.27	0.50	0.05
1995*	18.78	4.60	10.64	26.92	0.20	0.94	-0.23	0.64	0.10
2000*	18.05	5.99	12.05	24.06	0.21	1.48	-0.07	0.49	0.15
2005*	19.20	12.04	16.02	22.38	0.13	1.84	-0.01	0.28	0.10

TABLE 3.25 NON-OECD COUNTRIES — LONG RUN IMPACT OF NATIONAL SAVING ON INVESTMENT

	$\beta_{0,t}$	t-stat	-95%	+95%	$\beta_{1,t}$	t-stat	-95%	+95%	R^2
1975	12.44	8.17	9.38	15.51	0.53	6.72	0.37	0.69	0.49
1980*	14.10	5.63	9.06	19.15	0.54	4.41	0.29	0.78	0.48
1985*	15.17	6.43	10.42	19.92	0.45	3.79	0.21	0.69	0.38
1990*	14.22	7.21	10.25	18.19	0.40	4.27	0.21	0.58	0.42
1995*	16.10	4.95	9.55	22.65	0.37	2.29	0.05	0.70	0.36
2000*	13.59	7.94	10.14	17.03	0.46	6.57	0.32	0.60	0.48
2005	14.22	9.14	11.09	17.35	0.41	6.13	0.28	0.55	0.44

TABLE 3.26 NON-OECD, NON OIL EXPORTING COUNTRIES — LONG RUN IMPACT OF DOMESTIC SAVING ON INVESTMENT

	$\beta_{0,t}$	t-stat	-95%	+95%	$\beta_{1,t}$	t-stat	-95%	+95%	R^2
1975*	16.25	9.00	12.65	19.86	0.26	2.19	0.02	0.50	0.20
1980*	20.31	8.36	15.46	25.16	0.17	1.28	-0.09	0.42	0.11
1985*	20.05	7.58	14.77	25.32	0.12	0.73	-0.21	0.45	0.06
1990*	18.98	5.50	12.09	25.87	0.10	0.52	-0.29	0.49	0.04
1995*	18.86	4.50	10.49	27.23	0.20	0.81	-0.29	0.68	0.08
2000*	18.14	5.51	11.56	24.71	0.20	1.14	-0.15	0.54	0.11
2005*	19.19	10.41	15.51	22.87	0.13	1.31	-0.07	0.34	0.07

TABLE 3.27 NON-OECD, NON OIL EXPORTING COUNTRIES — LONG RUN IMPACT OF NATIONAL SAVING ON INVESTMENT

	$\beta_{0,t}$	t-stat	-95%	+95%	$\beta_{1,t}$	t-stat	-95%	+95%	R^2
1975*	13.08	5.50	8.28	17.87	0.48	3.19	0.18	0.78	0.40
1980*	15.03	6.02	9.99	20.07	0.46	3.67	0.21	0.72	0.38
1985*	15.50	6.39	10.60	20.39	0.42	3.36	0.17	0.68	0.33
1990*	14.29	7.21	10.29	18.29	0.39	4.20	0.20	0.58	0.42
1995*	16.28	5.03	9.75	22.82	0.37	2.25	0.04	0.70	0.36
2000*	13.49	7.76	9.98	17.00	0.47	6.29	0.32	0.62	0.47
2005	13.66	8.40	10.38	16.94	0.46	6.09	0.31	0.61	0.46

Notes: * indicates correction for heteroskedasticity.

4 MOTIVATING DOMESTIC INVESTMENT

4.1 INTRODUCTION

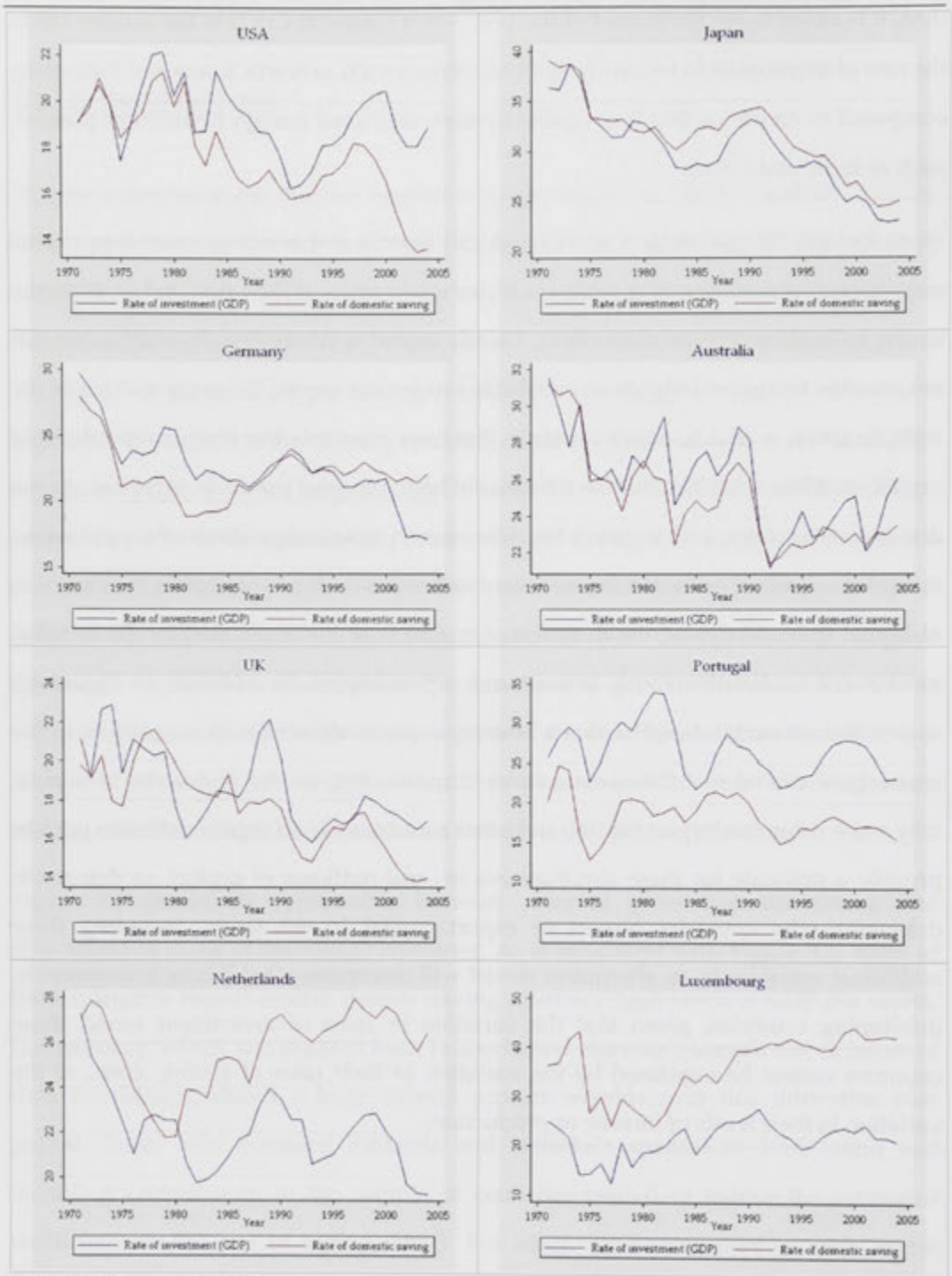
Chapter 3 demonstrated that the Puzzle no longer applies to OECD countries, and has never applied strongly to developing countries. The fact that capital is internationally mobile is now supported by evidence of the non-zero current account balances of most countries, and the non-unity correlation between rates of investment and saving across countries. The previous chapter also showed that the coefficient on the rate of saving is higher for the sample of developing countries than for OECD countries, which implies that on average, a developing country is more likely to retain saving as domestic investment. This is consistent with poorer countries having less sophisticated financial markets than richer countries. The fact that poorer countries are exporting any capital at all to the OECD countries, however, is at odds with the diminishing marginal returns to capital that characterise the neo-classical model. The fact that this is happening shows that, as with empirical tests of the neo-classical growth model, it is necessary to control for variables other than income and the rate of saving when seeking to understand what determines a country's rate of investment.

Figure 4.1 shows the relationship between rates of gross domestic saving and investment in some of the OECD countries. As is consistent with Figure 3.1, some of these countries import capital, despite having relatively high levels of GDP per capita. Luxembourg, which was omitted from Feldstein and Horioka's sample due to issues of data consistency, shows a large current account surplus over this thirty-five year period. Tesar, who extended Feldstein and Horioka's analysis to 1986 found that including Luxembourg in the sample of countries tended to reduce the estimated coefficient on the rate of saving (1991). For other OECD countries — such as the Netherlands and the USA as shown — the gap between rates of investment and saving has grown over time. Figure 4.2 shows rates of gross domestic saving and investment for non-OECD countries. Rates of investment and saving in natural resource intensive economies such as Botswana and Lesotho (diamonds) and Saudi Arabia and Venezuela (oil) are almost totally independent of one another. In the Asian countries shown, the

relationships between rates of investment and saving are more closely linked, but even then, it is easier to see the impact of the 1997 Asian Financial Crisis in the sudden fall in the rate of investment in relatively open economies such as South Korea and Indonesia, compared to countries that had relatively more restricted foreign investment policies, such as India and China.

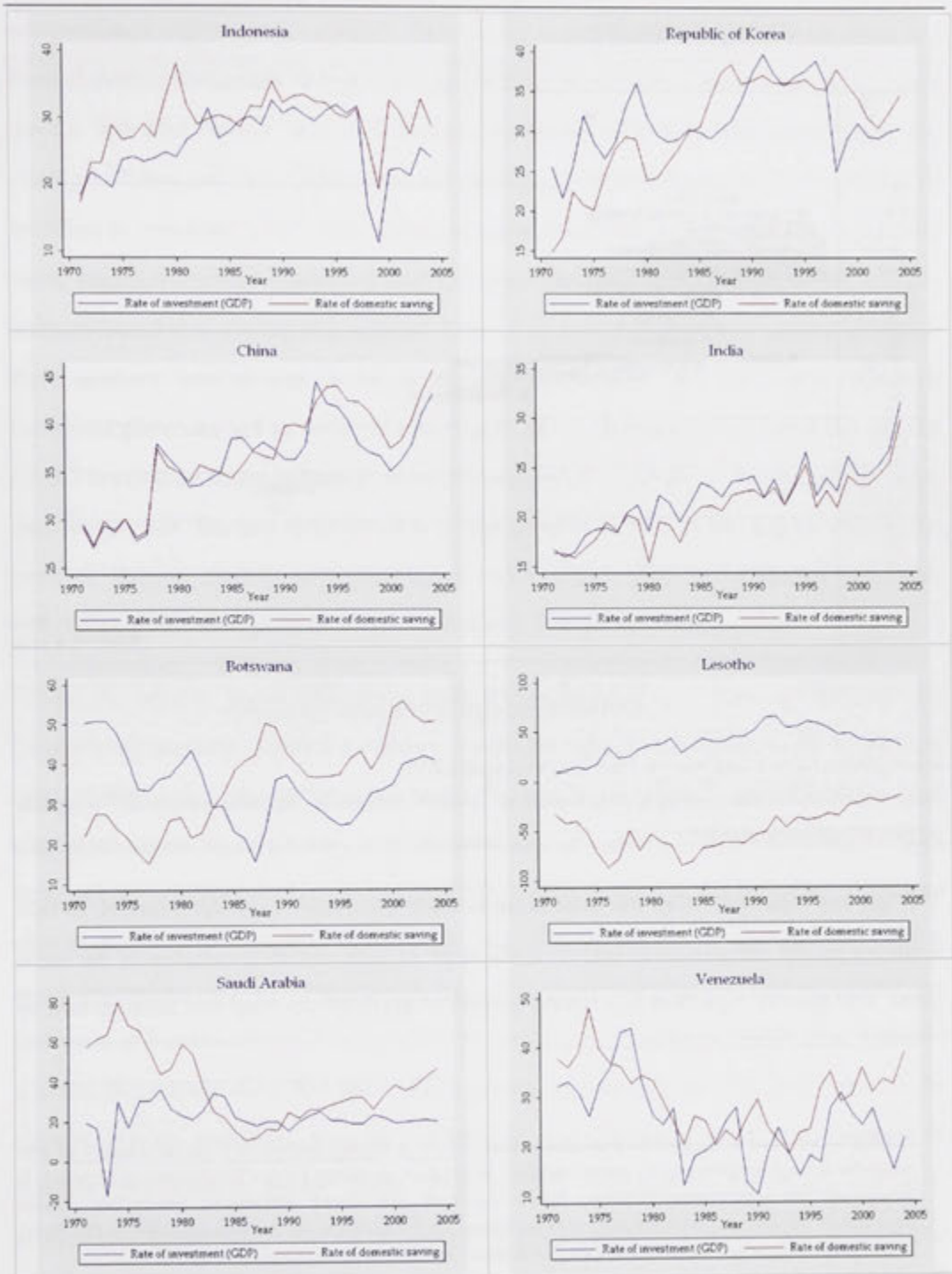
From looking only at rates of investment and saving, and levels of income or capital per capita, it is not clear why some countries retain more of their national or domestic saving as local investment than others. Clearly capital is internationally mobile, but it is not possible to make a judgement on whether or not net capital flows are moving in the right direction — that is, out of countries that have relatively low marginal products of capital, and into countries that have relatively high marginal products of capital. As the discussion in section 2.4.2 showed, the difference in marginal products of capital across countries — even if corrected for measurement errors — does not explain the direction of capital flow. Analysing the direction of capital flow is complicated by the fact that most countries simultaneously import and export capital. In addition, as Figure 4.3 shows, the amounts of capital that a country exports are similar in magnitude to the amounts of capital that the same country imports. Any model that seeks to explain why some countries import capital, and other countries export capital, will also need to provide a rationale for these simultaneous in- and outflows of capital, so that it can determine why countries import or export capital in net terms. Including these additional variables in an alternative model will determine what drives investment in developing countries, given that the variation in rates of investment across these countries cannot be explained by the variation in their rates of saving alone, or the variation in their levels of income or production.

FIGURE 4.1 INVESTMENT AND SAVING RATIOS — SELECTED OECD COUNTRIES



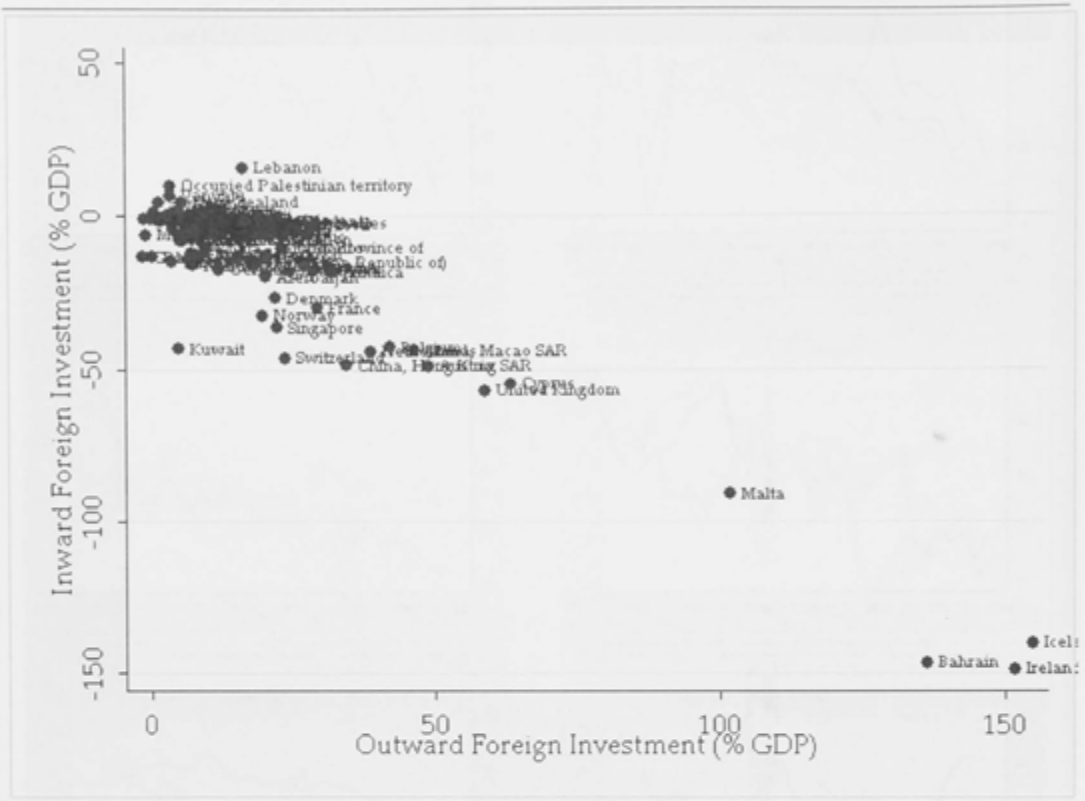
Source: (The World Bank, 2009)

FIGURE 4.2 INVESTMENT AND SAVING RATIOS – SELECTED NON-OECD COUNTRIES



Source: (The World Bank, 2009)

FIGURE 4.3 INWARD AND OUTWARD FOREIGN INVESTMENT FLOWS, SELECTED COUNTRIES FOR 2007



Source: (United Nations Conference on Trade and Development, 2010)

Notes: Investment flows are made up of direct investment,[30] portfolio investment,[31] and 'other investment'.[32] It excludes changes in the holdings of reserves.[33]

The 'gravity equation' from the international trade literature is one such model, in that it allows for the simultaneous import and export of differentiated varieties of the same good. The gravity equation has strong empirical applications, and has been shown to

[30] "Direct investment is defined as investment that reflects a lasting interest of a resident entity of one economy (direct investor) in an entity resident in another economy (direct investment enterprise). It covers all the transactions between direct investors and direct investment enterprises. Direct investment implies a significant degree of influence by the investor on the management of the direct investment enterprise." (United Nations Conference on Trade and Development, 2010)

[31] "Within portfolio investment the distinction is being made between assets and liabilities. Assets are viewed as claims on the rest of the world and liabilities as indebtedness to the rest of the world. Portfolio investment covers transactions in equity securities and debt securities. The latter are subdivided into bonds, notes, money market instruments and financial derivatives (when the derivatives generate financial claims or liabilities)." Ibid.

[32] "Other investment is a residual category that covers all financial transactions not included under direct investment, portfolio investment or reserve assets. Assets and liabilities in this category are classified primarily on an instrument basis, such as trade credits, loans, currency and deposits etc." Ibid.

[33] Reserve assets include "monetary gold, special drawing rights, reserve position in the IMF, foreign exchange and other claims" (United Nations Conference on Trade and Development, 2010).

predict the magnitude of bilateral trade flows of goods, using the size of the countries' economies as explanatory variables. Even in its simple form, the gravity equation has been shown to accurately reflect the magnitude of international movement of not only goods, but also labour and investment (Anderson and van Wincoop, 2003). For example, Portes and Rey (1998) fitted the gravity model to bilateral trade in equities. In addition to countries' GDPs, they included variables for countries' populations, growth rates, regional dummy variables, and the physical distance between countries.[34] The authors found that the log of countries' GDPs had strong explanatory power, although their primary interest was in the coefficient on distance, and the extent to which increased distances led to reduced investment flows. Brenton et. al. fitted the gravity model to bilateral flows of foreign direct investment in a sample of European countries, and found that 'the key determinants of the growth of FDI to the region will be the pace of income growth and the success with which [the] governments [of those countries] orient their policies to be conducive to business' (1999, p. 119).

While the simple gravity equation tests well empirically, it does not provide an intuitive explanation for why a country would manufacture and export the same type of good that it also imports from the rest of the world. The simple gravity equation was expanded upon by Anderson, who allowed for the prices of traded goods to vary between the countries doing the trading (1979). This motivated the inclusion of 'border effects', to allow for transport costs, tariffs and other distortions to change the price of a good depending on where the good is sold. Anderson and van Wincoop noted that the inclusion of border effects in empirical work corrects for omitted variable bias, and was a better fit for trade data than the simpler gravity equation (2003). Their criticism of the simple gravity equation was in relation to the equation as it was applied to international capital flows, since most of the explanatory variables (distance, population, GDP) were beyond the scope of policy-makers to influence. Introducing border effects to a gravity equation analysis of international capital flows meant that it would be possible to identify variables that influence households' investment

[34] With respect to this last, the authors noted that they interpreted 'the effect of distance as representing informational asymmetries, currency risk, and institutional differences' (Portes and Rey, 1998, p. 423).

decisions, and that could also be directly affected by policy initiatives aimed at attracting and retaining investment.

This chapter considers the extent to which the variables that drive cross-country differences in production technology, and which are used in tests of conditional convergence, can be used to explain the net movement of capital into or out of a country. The gravity equation with border effects from the international trade literature is used as a framework to discuss how these variables are expected to affect domestic households' investment decisions. Given that capital is internationally mobile and unrestricted, capital should flow out of countries with relatively low rates of return, and into countries with relatively high rates of return. And if the flow is not from rich to poor countries, then controlling for the variables that affect production technologies — health, education, institutional quality, and so on — makes it possible to infer why this is the case, and what can be done to motivate domestic investment. This chapter is split into four sections. This first has provided some background. The second describes how the gravity equation can be applied to the international movement of capital. The third section builds on the second, and develops a framework for analysing the magnitude and direction of the current account. The fourth section summarises and concludes.

4.2 THE GRAVITY EQUATION

The simultaneous in and outflow of capital from individual countries, where the magnitude of the outflow is similar to the magnitude of the inflow, is an outcome of conditions that are akin to those of the 'intra-industry trade' model from international trade theory. Intra-industry trade occurs when a country exports to the rest of the world the same good or service that it also imports from the rest of the world.

4.2.1 INTERNATIONAL TRADE IN GOODS AND SERVICES

The rationale for intra-industry trade begins with the gravity equation,[35] which predicts the value of gross trade (the absolute value of exports plus the absolute value of imports) between two countries as being a function of the size of their economies. Specifically, the volume of trade between two countries is a function of the size of their economies as a proportion of the size of the global economy, given by equation (4.1) when: trade is balanced; goods can move between countries without price or volume restrictions; the preferences and budget constraints that drive the demand for goods are identical across countries; and markets are perfectly competitive:

$$X^{ij} + X^{ji} = \left(\frac{2}{Y^w}\right) Y^i Y^j \tag{4.1}$$

The total value of trade that the two countries conduct with one another is made up of exports from country i to country j (X^{ij}) and imports to country i from country j (X^{ji}). The gravity equation presents these as a function of each country's GDP, and global GDP (Y^i, Y^j and Y^w). Since trade is balanced and there is no inter-temporal substitution, a country's output is equal to its expenditure, which in turn is equal to its income. If trade were not balanced, X^{ij} would be the product of country i's production and country j's expenditure (and income, in the absence of inter-temporal substitution) divided by global GDP (where global GDP is equal to global income, output and expenditure), and vice versa for X^{ji}. This means that the total value of trade can be explained by variables that take into account or that reflect the demand for goods (one country's income and expenditure) as well as the supply of goods (the other country's production).

In the same year that Anderson introduced controls for 'border effects' in the gravity equation, Krugman developed a model of monopolistic competition for traded goods, where firms specialised in differentiated varieties of a particular type of good (1979).

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[35] All of the derivation and description of the model in this section is taken from Feenstra's *Advanced International Trade: Theory and Evidence* (Feenstra, 2004).

Consumer preferences were based on the Dixit and Stiglitz 'love of variety' preference function, to motivate international trade in goods between countries that manufactured, imported and exported different varieties of the same good (1977). This love of variety, combined with the border effects and a monopolistically competitive market for goods for firms, produced a variation on the gravity equation that could be used to rationalise the simultaneous import and export of differentiated varieties of what is essentially the same good.

4.2.2 INTERNATIONAL INVESTMENT

Intra-industry trade is motivated using a constant elasticity of substitution (CES) consumer preference function that implies a love of variety, where $\sigma > 1$ is the household's elasticity of substitution between products.[38] Utility for the representative household in country j is a function of products consumed, summed over types of products (k), and the countries (i) from which these products originate.

$$U^j = \sum_{i=1}^{C} \sum_{k=1}^{N} (c_k^{ij})^{(\sigma-1)/\sigma} \tag{4.2}$$

Feenstra (2004) optimised this preference function against a budget constraint in which the value of the products consumed (products c^{ij}, valued at prices p^{ij}, across the number of varieties from country i, N^i) is set as equal to income (Y^j):

$$Y^j = \sum_{i=1}^{C} N^i p^{ij} c^{ij} \tag{4.3}$$

This gives the following expression for exports from country i to country j:

$$X^{ij} = N^i Y^j \left(\frac{T^{ij} p^i}{P^j} \right)^{(1-\sigma)} \tag{4.4}$$

[38] The version presented here is once again taken from Feenstra (Feenstra, 2004) , which in turn is based on the work of Redding and Venables (Redding and Venables, 2004) .

The value of exports from country i to country j is shown as an increasing function of the number of varieties of goods produced in country i (N^i), income in country j (Y^j), and the prices of the imported goods ($T^{ij}p^i$), and a decreasing function of domestic prices (P^j). The first derivatives for the magnitude of trade with respect to each of the variables in the equation are consistent with the intuition for demand for and trade in normal goods. The value of exports increases with respect to the number of varieties, the importing country's income, and the price of goods in the importing country, and it decreases with respect to the prices of the goods being imported, and the iceberg costs associated with these goods.

The gravity equation with border effects in (4.4) is superior to the gravity equation in (4.1) because it allows for variables other than simply a country's total income and expenditure (Y^j) to affect the value of its imports from another country. In this way, it introduces a number of additional relevant variables that were omitted from the simple gravity equation. The gravity model with border effects was developed and tested to solve the 'home bias in trade' puzzle — another of Obstfeld and Rogoff's (2001) major puzzles in macroeconomics — in which it was found that the volume of trade between Canadian provinces in 1988 was 22 times greater than the volume of trade between Canada and the USA. Anderson and van Wincoop (2003) tested the gravity equation with border effects for trade flows between the USA and Canada, and found that the presence of borders reduced by 44 % compared to what trade between Canada and the USA would have been in 1993 if these borders did not exist (2003, p. 171).

In the case of international capital movement, the simplest way to motivate investment across a range of types of capital goods or types of investments is to apply the love of variety to an investor's preference function, and have them prefer a larger number of types of investment in their portfolio than a smaller number, for the same expected return. Assuming that none of the potential investment activities are perfectly positively correlated with one another, allocating the same value of investment across a greater number of types of investments will reduce the risk associated with the expected return on that portfolio, and make the diversified portfolio more appealing to a risk-averse investor.

On the supply side, the market for investment must be a monopolistically competitive one in order to generate the necessary intra-industry trade outcomes. Firms need to attract investors to finance the necessary capital inputs for whatever economic activity generates output, and through it the return on capital. While the investment instruments themselves — debt, equity or currency — are fully fungible, each firm proposes to undertake a unique economic activity that uses the capital as an input to generate returns for investors. This gives firms some monopoly power over the financial instruments they can offer investors, however, firms cannot fully exploit this power because investors are risk averse, and one investment instrument can be substituted for another with relative ease. An investor will therefore not pay a higher price (or accept a lower return) on a financial instrument offered by a firm unless the associated risk is also reduced.

With investors' preferences reflecting a love of variety in their investment portfolios, and firms competing for investors' money in a monopolistically competitive market, it is possible to apply the gravity equation with border effects distinguishes a country's investment from its saving. The application to trade in goods assumed that a country's income was equal to its production and consumption, because trade was balanced, and the production function required only labour and no capital. This meant that there was no saving or investment, and no lending to or borrowing from the rest of the world. In the analysis in this thesis, current and capital accounts are permitted to be unbalanced at any point in time.[40] This allows countries to borrow from and lend to the rest of the world on net, and allows income, production, and expenditure to vary. Finally, the production function is based on that of the neo-classical growth model, and therefore requires both capital and labour as inputs, which means that households' income can be either consumed or saved.

[40] Capital and current accounts are not necessarily balanced in this static analysis. They may, however, be balanced dynamically, with deficits in some periods being entirely off-set by surpluses in others, although that is not the focus of this thesis.

HOUSEHOLDS

As in the Solow-Swan model, the rate of saving (s_H) in the home country (H) is exogenous. Once the rate of saving is known, the gravity equation with border effects can be applied to predict how much of that saving is invested domestically, and how much is exported, as well as how much capital is imported from the rest of the world. The level of saving in the home country (S_H) is simply the rate of saving multiplied by Y_H, which can be either income or production. S_H is the maximum amount that can be used as investment. All of the saving in a period is invested either domestically or overseas. Investment occurs through the purchase of a single type of financial instrument — bonds (B). These bonds constitute a promise to pay, at some specified point in the future, by firms who sell them in order to raise capital as inputs for the economic activities that generate production.

Households purchase bonds based on their preferences for the risk associated with an investment, their preferences for the type of economic activity they are financing, or some combination of the two. The preference function is identical to equation (4.2), except that the preference function in equation (4.5) shows that the home country H's households' utility (U_H) is based on their selection of bonds ($B_{k,fH}$) that finance economic activity k in foreign country f, summed across the number of different economic activities (N_f) in each foreign country f from which the investments originate.

$$U_H = \sum_{f=1}^{F} \sum_{k=1}^{N_f} (B_{k,fH})^{(\sigma-1)/\sigma}, \sigma > 1 \tag{4.5}$$

As with the market for goods,[41] the utility function is simplified to a single summation index, to give the following:

$$U_H = \sum_{f=1}^{F} N_f (B_{fH})^{(\sigma-1)/\sigma} \tag{4.6}$$

[41] The alternative model is based on the model for international trade in goods from Feenstra FEENSTRA, R. C. (2004) *Advanced International Trade: Theory and Evidence*, Princeton, Princeton University Press.

The value of bonds that can be purchased is constrained not by country H's income or production (Y_H), but by the amount of income that has been allocated as saving, which has been exogenously determined as s_H. Households therefore maximise utility by allocating saving across different investments based on the preferences given in equation (4.6), and with respect to the budget constraint in equation (4.7):

$$s_H \bullet Y_H = S_H \geq \sum_{f=1}^{F} N_f p_{fH} B_{fH} \tag{4.7}$$

The total number of country f's bonds (B_{fH}) purchased by country H at price (p_{fH}) for all of the number of types of economic activities that the bonds finance (N_f) can be no greater than the total value of the home country's level saving (S_H) in any given period. If any saving is retained as domestic investment, then country H's investments offshore will necessarily be less than total saving.

FIRMS

Each firm is assumed to be engaged in a unique type of economic activity (k), where output (Y_k) is a function of labour (L), capital (K), and the production technology that is particular to that firm (A_k). While it is not formally specified at this stage, the production function is assumed to have the properties of the neo-classical growth model. The production technology, and the rate at which it improves, are exogenous.

$$Y_k = F(A_k, L, K) \tag{4.8}$$

This production function is the one that firms use to convert inputs into final products, and is not an analogue to the production function that underpins the supply of traded goods in Feenstra's gravity equation with border effects. Since each bond is a promise to pay an agreed amount at some specified time in the future, it would seem that the bond supply is unlimited, since anybody can write out a promise to pay. Of necessity, therefore, this construction of a supply function for bonds departs from that used in the gravity equation with border effects for trade in goods.

Households are assumed to have a non-zero rate of time preference (ρ_H), which is used to introduce a minimum rate of return in the market for bonds. Households are also

able to evaluate the expected return on investment based on their knowledge of a firm's production technology, the amounts of capital and labour that are currently used by that firm, as well as some indication of how risky an investment in that firm might be. This is enough information to give some indication of the expected return on the investment. An investor's willingness to pay for a bond from one firm over that firm's competitors therefore depends on the firm's ability to generate a return that sufficiently compensates that investor for their patience, and their risk tolerance. If a firm employs insufficient labour, and has either no intention or no ability to employ additional labour (for example, the country is at full employment, and the firm is not able to entice workers away from other firms by offering a higher wage) during the year, then the expected return on investment will be low.

On the other hand, the firm may be able to employ extra labour if there is un(der)employed labour, or if the firm is in possession of a production technology that will enable it to offer a higher wage, which in turn will enable it to entice the labour it needs away from other firms. Or, it may not need to employ any extra labour if the capital is intended to replace out dated or run-down existing stock, as a result of which there is no net increase to the firm's capital. Unlike in the open economy neo-classical models, the international market for capital is monopolistically rather than perfectly competitive, and so firms' marginal products of capital are not equal to a global rate of interest. Defined in this way, the supply of bonds in the home country (ϑ_H) is not formally parameterised, but is an increasing function (G) of labour (L_H), the average level of technology across all firms (A_H), and the depreciated stock of capital that needs to be replaced (δK_H) — as shown in equation (4.9).

$$\vartheta_H = G\left(L_H, A_H, \delta K_H\right) \tag{4.9}$$

Since the production function that firms use is neo-classical, and individual factors of production have diminishing marginal products, the availability of labour and technology affects the rate of return that a firm can offer for one of its bonds. Assuming that bonds have no coupon payments, and that investors pay for a bond that can be redeemed at maturity for the face value (FV), the relationship between the price (p_H) and the return on the bond (r_H) is:

$$p_H = \frac{FV}{(1+r_H)} \tag{4.10}$$

In order to supply bonds that investors will actually consider, a firm needs to offer a return that it is capable of generating, and that is less than or equal to, the expected marginal product of its capital ($E(MPK_H)$) as well as more than investors' rate of time preference in the most patient country (ρ_{max}). The maximum and minimum range for bond prices is given by the following inequality:

$$\frac{FV}{(1+E(MPK_H))} \leq \frac{FV}{(1+r_H)} \leq \frac{FV}{(1+\rho_{max})} \tag{4.11}$$

As long as there is a minimum rate of return, or maximum price that a bond can be sold for, the supply of bonds is limited by the availability of labour, technology, and the level of depreciation, since these variables drive a firm's need for new or additional capital. The rate of depreciation is exogenous, and this alternative model treats the availability of labour and technology as also being exogenous.[42] For a given amount of labour and level of technology, the highest value of investment that a country's firms can offer, where each investment is associated with a bond that pays a return of at least ρ_{max}, is ϑ_H by definition. For the entire country, an exogenous increase in labour (through increased fertility or decreased mortality and morbidity) or an exogenous increase in the level of technology (through the rate of technological progress, and all that it encompasses) means that firms can offer higher returns on the same amount of capital. For some firms, this may mean that they can now offer a return that is greater than or equal to ρ_{max}. In this way, the supply of bonds is an increasing function of labour and technology — as stated in equation (4.9).

[42] For empirically testing this alternative model, it will be necessary to control for differences in the supply of bonds — and the availability of labour and technology — across countries, or over time. The issues associated with doing so are discussed subsequently.

EQUILIBRIUM

The price of bonds at equilibrium cannot be solved for in this simple model, as this model does not reflect the extensive literature on financial asset pricing, risk measurement and management, and portfolio optimisation. Nevertheless, it is possible to control for cross-country differences in the price of bonds by including variables that determine the return on investment. The highest and the lowest price a firm can demand for its bonds are still as they are shown in inequality (4.11), but investors will evaluate for themselves — based on their knowledge of the firm's risk profile, access to complementary factors of production, and production technology. They will only consider a bond for purchase if the return is sufficient to compensate their rate of time preference ($r_H \geq \rho_H$), and if they feel that the firm is capable of successfully generating the output necessary to repay the face value of the bond ($E(MPK)_H \geq r_H$).

Investors are assumed to be risk averse, which is necessary to motivate the preference for a diversified investment portfolio. Since the return on capital is repaid entirely to investors,[43] the price of the bond at the point of sale will be determined by the expected return on investment, which is in turn equal to the firm's expected marginal product of capital — as shown here:

$$p_H = \frac{FV}{\left(1+E\left(MPK_H\right)\right)} = \frac{FV}{\left(1+E\left(r_H\right)\right)} \leq \frac{FV}{(1+\rho_H)} \leq \frac{FV}{(1+\rho_{\max})} \tag{4.12}$$

Firms that do not have a sufficiently high enough expected marginal product of capital will not be able to raise any capital. At the other end of the spectrum, some firms will be offering a bond that investors find extremely attractive, to the point where the firm can offer a return that is close to the risk-free rate of return, or just enough to meet investors' rates of time preference.

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[43] In a more complex model, the return on capital could be split between those who own the firm, and those who operate the firm — doing this would allow for the return on the bond to differ from the marginal product of capital of the firm. This complication is not attempted in this model, and it is assumed that an investor receives the entire marginal product of capital.

The amount of investment that is realised in equilibrium is determined using the optimisation problem for investors, and returns to Feenstra's gravity equation with border effects. Households maximise utility by solving the optimisation problem given in equation (4.6) subject to the budget constraint in equation (4.7). When $F = 2$, the Lagrangian for this optimisation problem is:

$$L = N_1 B_{1H}^{\varphi} + N_1 B_{1H}^{\varphi} + \lambda\left[S_H - N_1 p_{1H} B_{1H} - N_2 p_{2H} B_{2H}\right] \tag{4.13}$$

where $\varphi = \dfrac{(\sigma - 1)}{\sigma}$. This gives the following first order conditions:

$$\frac{\delta L}{\delta B_{1H}} = \varphi N_1 B_{1H}^{(\varphi-1)} - \lambda N_1 p_1 = 0 \tag{4.14}$$

$$\frac{\delta L}{\delta B_{2H}} = \varphi N_2 B_{2H}^{(\varphi-1)} - \lambda N_2 p_2 = 0 \tag{4.15}$$

$$\frac{\delta L}{\delta \lambda} = S_H - N_1 p_{1H} B_{1H} - N_2 p_{2H} B_{2H} = 0 \tag{4.16}$$

Equation (4.14) can be solved for B_{1H} to give:

$$B_{1H} = \left(\frac{\lambda p_1}{\varphi}\right)^{\left(\frac{1}{\varphi-1}\right)} \tag{4.17}$$

Similarly, equation (4.15) can be solved for B_{2H}. The solutions for both B_{1H} and B_{2H} can be substituted into equation (4.16) and solved for λ. Re- applying the summation across foreign countries 1 and 2 gives the following expression for λ:

$$\lambda = \varphi\left[\frac{S_H}{\sum_{f=1}^{F} N_f p_f^{\left(\frac{\varphi}{\varphi-1}\right)}}\right]^{(\varphi-1)} \tag{4.18}$$

Finally, (4.18) can be substituted into equation (4.17) to give the function for demand for B_{1H} with respect to price:

(4.19)
$$B_{1H} = p_1^{\left(\frac{1}{\varphi-1}\right)}\left[\frac{S_H}{\sum_{f=1}^{F} N_f p_f^{\left(\frac{\varphi}{\varphi-1}\right)}}\right]$$

Simplifying this gives the following expression for the demand for bonds from foreign country f purchased by home country H's investors.[44]

(4.20)
$$B_{fH} = \left(\frac{S_H}{P_H}\right)\left(\frac{P_H}{p_{fH}}\right)^{\sigma}$$

The value of saving in home country H that is invested in foreign country f is the number of types of bonds issued by firms in foreign country f (N_f), multiplied by the price of bonds that are issued in foreign country f (p_{fH}) and purchased by households in home country H, multiplied by the number of types of investments:

(4.21)
$$S_{fH} \equiv N_f p_{fH} B_{fH}$$

By substituting equation (4.20) for B_{fH} in equation (4.21), equation (4.22) shows the amount of home country H's saving that is invested in foreign country f as a function of total saving, relative bond prices, and the number of types of investments in foreign country f:

(4.22)
$$S_{fH} = N_f S_H \left(\frac{P_H}{p_{fH}}\right)^{(\sigma-1)}$$

Feenstra noted that it is difficult to estimate N_f directly for empirical purposes (2004), however, based on his workaround for trade in goods, the supply of bonds can be determined as the total value of different types of bonds, their prices, and the number that are on offer:

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[44] P_H represents country H's overall price index for bonds purchased from around the world, given by the following equation:

$$P_H = \left(\sum_{f=1}^{F} N_f \left(p_{fH}\right)^{(1-\sigma)}\right)^{1/(1-\sigma)}$$

$$\begin{aligned} \vartheta_f &= G\left(L_f, A_f, \delta.K_f\right) \\ &= N_f \bullet p_f \bullet \overline{f} \end{aligned} \tag{4.23}$$

The supply of bonds issued by a foreign country in equilibrium is equal to the number of types of bonds multiplied by the price of bonds, multiplied in turn by the number of bonds of each type that are issued. For simplicity, it is assumed that each firm issues the same number of bonds ($\overline{f}$), albeit not at the same price. Unlike the model for the trade of goods, the total supply of bonds is not equal to total income or output for the foreign country (Y_f). Rather, bonds finance the capital that is one of the inputs required for Y_f. After solving equation (4.23) with respect to N_f, it can be substituted into equation (4.22) to give the following expression:

$$S_{fH} = \left(\frac{S_H \vartheta_f}{(p_f \bullet \overline{f})}\right)\left(\frac{P_H}{p_{fH}}\right)^{(\sigma-1)} \tag{4.24}$$

As with the trade in goods model, p_{fH} can be unpacked into the components p_f — the price of the bond in foreign country f — and T_{fH} — the iceberg cost of transporting the bond from foreign country f to the home country H. For international trade in capital T_{fH} represents anything that differentiates the return on investment from the marginal product of capital for a foreign investor — such things include differences between taxation requirements for residents of a country and requirements on overseas investors, or differences in the costs associated with obtaining information about or monitoring the performance of an investment. Importantly, these are costs that only apply to international transactions, or that disproportionately affect foreign investors. Factors such as taxation regimes more generally, corruption, bribery or political and economic instability are assumed to affect domestic and foreign investors equally.

Effectively, the specification for the amount of saving in home country H that is invested in foreign country f is given by:

$$S_{fH} = \left(\frac{S_H \vartheta_f}{(p_f^{\sigma} \bullet \overline{f})}\right)\left(\frac{P_H}{T_{fH}}\right)^{(\sigma-1)} \tag{4.25}$$

S_{fH} is an increasing function of the amount saved in the home country H (S_H) and the supply of investment opportunities in foreign country f (ϑ_f). As long as $\sigma > 1$, it is also an increasing function of P_H — the higher the price of bonds in the home country H (and by equation (4.12), the lower the expected rate of return on investment in the home country H), the more of country H's saving is invested in foreign country f. By the same token, S_{fH} is a decreasing function of both T_{fH} and p_f — the higher the price of bonds in foreign country f or the more that the rate of return earned in foreign country f is eroded, the lower the value of the home country H's saving that is invested in foreign country f.

4.3 RETAINING SAVING

4.3.1 THE CURRENT ACCOUNT

The purpose of this chapter is to develop a model to analyse bilateral trade flows. To do so, equation (4.25) can be used to develop an expression for the current account, where the current account is measured as the difference between a country's saving and investment:

$$\begin{aligned} S_H - I_H &= CAB_H \\ I_H &= S_H - CAB_H \\ &= S_H - S_{FH} + S_{HF} \end{aligned} \tag{4.26}$$

An expression for home country H's total outward investment in the rest of the world (S_{FH}) can be obtained by treating the world as being made up of two countries — the home country (H), and the rest of the world (F), which accounts for all foreign countries. This gives the expression for capital exported from the home country H to the rest of the world:

$$S_{FH} = \sum_{f=1}^{F} S_{fH} = \left(\frac{S_H \vartheta_F}{(p_F^{\sigma} \overline{F})} \right) \left(\frac{P_H}{T_{FH}} \right)^{(\sigma-1)} \tag{4.27}$$

In the same way, equation (4.28) is an expression for the rest of the world's investment in country H (S_{HF}) — simply the mirror image of equation (4.27).

$$S_{HF} = \sum_{f=1}^{F} S_{Hf} = \left(\frac{S_F \vartheta_H}{(p_H^{\sigma} \overline{H})} \right) \left(\frac{P_F}{T_{HF}} \right)^{(\sigma-1)} \tag{4.28}$$

From this, the current account balance for the home country H can be shown as:

$$\begin{aligned} CAB_H &= S_H - I_H \\ &= S_{HF} - S_{FH} \\ &= \left(\frac{S_H \vartheta_F}{(p_F^{\sigma} \overline{F})} \right) \left(\frac{P_H}{T_{FH}} \right)^{(\sigma-1)} - \left(\frac{S_F \vartheta_H}{(p_H^{\sigma} \overline{H})} \right) \left(\frac{P_F}{T_{HF}} \right)^{(\sigma-1)} \end{aligned} \tag{4.29}$$

Equation (4.29) provides a framework for analysing why countries import or export capital on net. The factors that drive the relative attractiveness of domestic bonds, compared to bonds in the rest of the world, are reflected in investors' budgets (S), the prices for and rates of return on bonds (P and p), iceberg costs that erode rates of return and increase prices (T), and the supply of bonds (ϑ), both at home and abroad.

Equation (4.30) shows the current account balance as a proportion of the home country H's income Y_H, where Y_H can be either GDP or GNI, depending on whether domestic or national saving and investment are of interest, and θ_H is defined as the ratio of ϑ_H to Y_H:

$$\begin{aligned} \frac{CAB_H}{Y_H} &= \frac{S_H \left(\frac{\vartheta_F}{(p_F^{\sigma} \overline{F})} \right) \left(\frac{P_H}{T_{FH}} \right)^{(\sigma-1)} - \vartheta_H \left(\frac{S_F}{(p_H^{\sigma} \overline{H})} \right) \left(\frac{P_F}{T_{HF}} \right)^{(\sigma-1)}}{Y_H} \\ &= \frac{S_H}{Y_H} \left(\frac{\vartheta_F}{(p_F^{\sigma} \overline{F})} \right) \left(\frac{P_H}{T_{FH}} \right)^{(\sigma-1)} - \frac{\vartheta_H}{Y_H} \left(\frac{S_F}{(p_H^{\sigma} \overline{H})} \right) \left(\frac{P_F}{T_{HF}} \right)^{(\sigma-1)} \\ &= s_H \left(\frac{\vartheta_F}{(p_F^{\sigma} \overline{F})} \right) \left(\frac{P_H}{T_{FH}} \right)^{(\sigma-1)} - \theta_H \left(\frac{S_F}{(p_H^{\sigma} \overline{H})} \right) \left(\frac{P_F}{T_{HF}} \right)^{(\sigma-1)} \end{aligned} \tag{4.30}$$

There is nothing in equation (4.30) that is inconsistent with the empirical work conducted so far, as it allows for countries' rates of saving and investment to move together, as well as for countries to import or export capital on net. Re-arranging equation (4.30) gives:

$$\frac{I_H}{Y_H} = \frac{S_H - \left(\frac{S_H \vartheta_F}{(p_F^\sigma \overline{F})}\right)\left(\frac{p_H}{T_{FH}}\right)^{(\sigma-1)} + \left(\frac{S_F \vartheta_H}{(p_H^\sigma \overline{H})}\right)\left(\frac{p_F}{T_{HF}}\right)^{(\sigma-1)}}{Y_H}$$

$$= \frac{S_H}{Y_H}\left[1 - \left(\frac{\vartheta_F}{(p_F^\sigma \overline{F})}\right)\left(\frac{p_H}{T_{FH}}\right)^{(\sigma-1)}\right] + \frac{\vartheta_H}{Y_H}\left(\frac{S_F}{(p_H^\sigma \overline{H})}\right)\left(\frac{p_F}{T_{HF}}\right)^{(\sigma-1)} \quad (4.31)$$

$$= s_H\left[1 - \left(\frac{\vartheta_F}{(p_F^\sigma \overline{F})}\right)\left(\frac{p_H}{T_{FH}}\right)^{(\sigma-1)}\right] + \theta_H\left(\frac{S_F}{(p_H^\sigma \overline{H})}\right)\left(\frac{p_F}{T_{HF}}\right)^{(\sigma-1)}$$

This provides the necessary framework for analysing the variables that affect a country's rate of investment, in terms of that country's response to changes in relative rates of return, the sizes of the different economies, and the costs of doing business across borders.

4.3.2 EXPLAINING THE PUZZLE

There are four ways in which this alternative model can accommodate perfectly correlated rates of saving and investment. The first way in which this alternative model can generate the paradoxical outcome is if the levels of saving and investment change by the same magnitude and in the same direction. This means that on net, there is no change to the current account balance, and that a change in the rate of saving is fully reflected in a change to the rate of investment at the national level — which is what Feldstein and Horioka inferred from their findings.

The second is through an external shock that directly affects GDP or GNI, but does not affect anything else in the model. This has the effect of changing the denominator Y_H, without any changes to the numerators — because saving, investment and the current account balance are converted into rates as a proportion of GDP or GNI. This means that rates of investment, saving and the CAB to GDP or GNI ratio will all three change in the same direction and in the same proportions. In practice, this is unlikely to happen with respect to GDP, since the sorts of shocks that affect a country's GDP would also affect that country's production technology and through it, that country's supply of investment opportunities and the expected return on investment. If the rates of investment and saving are calculated as proportions of GNI, however, then it is

possible for a country to experience a windfall income gain — such as an inflow of foreign aid, or an improvement in the terms of trade — that does not improve the production technology, and has no impact on the marginal product of capital. This is supported by the fact that rates of national investment and saving, which are calculated as proportions of GNI, are consistently more closely correlated than rates of domestic investment and saving, which are calculated as proportions of GDP.

The third way in which this alternative model can generate the paradoxical outcome is through a shock to a country's production technology. This will alter GDP, but does not leave the other variables in the model untouched. For example, a permanent shock can also affect households' budgets for consumption, investment and saving, as well as the rate of return that firms can offer on bonds, *and* the number of bonds that pay a return that is at least as high as the rate of time preference. The subsequent work on the Puzzle has focussed on this aspect, and suggested that the correlation in rates of investment and saving across countries is due to macroeconomic shocks that affect GDP *and* rates of saving, which are fully reflected as changes in the rate of investment. Analysing this in the framework of this alternative model, it suggests that countries' rates of saving change following an exogenous shock to their GDPs. This is because households have a preference for consumption smoothing, and any changes to income will be seen in the level of saving rather than the level of consumption.

While the consumption-smoothing rationale is relatively uncontroversial, what is not clear is why a shock to GDP should generate a similar change in the rate of investment. The alternative model explains this by increasing the domestic supply of bonds, and providing a positive shock to the production technology. To be permanent, the shock to a country's production technology must affect the bond supply of the home country H. Assuming that it is a positive exogenous shock, a higher level of domestic saving is associated with an improved production technology and a higher return on capital. This increases the inflow of capital into the home country H from the rest of the world. Further, the alternative model shows that *some* of this domestic saving will be invested overseas, except in the unlikely event that the supply of bonds in the rest of the world is exhausted ($\mathscr{B}_f = 0$). Taken together, the capital outflow from the increased domestic

saving could be off-set by the capital inflow from the increased supply of bonds, and show a change in the rate of investment that is equal to the change in the rate of saving.

Naturally, the extent to which a capital outflow is off-set by a capital inflow depends on the type of shock that affects the economy, and whether it affects that economy in isolation, or if the shock applies to the rest of the world. In her analysis of OECD countries, Tesar suggested that there are a number of macroeconomic shocks that could generate such results, and noted that 'permanent exogenous shifts in the rate of technological progress or population growth with imperfect labour mobility can explain the long-run co-movements between savings and investment, although this does not explain the short-run movements' (1991, p. 76). Kraay and Ventura (2000) also generated similar findings in their analysis of the relationship between OECD countries' rates of saving and their CAB to GDP ratios. In this case, an estimated coefficient approaching zero on the rate of saving suggests that saving and the current account balance are not correlated, and that instead, saving and investment are closely correlated. The authors noted that 'since common income shocks or shocks to the rates of population and productivity growth simultaneously affect saving and investment…the estimate of β [where β is the coefficient on the rate of saving, and the CAB to GDP ratio is the explanatory variable] is biased toward zero' (2000, p. 1156). These findings are both consistent with the framework in equation (4.31).

The fourth and final way in which this alternative model can generate rates of investment and saving that are close to one another is if the cost of conducting financial transactions across international borders is prohibitively high, in which case there will be little capital in or outflow. As T_{FH} moves towards infinity, the proportion of domestic saving that is invested overseas tends toward zero. The flow of foreign investment *into* the home country H also tends to zero when T_{HF} moves towards infinity. The opposite is true the closer iceberg costs are to one. While this does generates an outcome that is consistent with the Puzzle, if the lack of international capital mobility is due to excessively high transaction costs, then there is no Puzzle since these costs form an effective barrier to the free international movement of capital. The Feldstein and Horioka result was characterised as a Puzzle because it occurred in

spite of a perceived lack of barriers to international capital mobility in the OECD countries of that time.

4.3.3 IMPLICATIONS FOR POOR COUNTRIES

The discussion so far has shown the ways in which the Puzzle can be unpacked using the framework of the gravity equation. Rates of investment and saving can be perfectly correlated for any one or more of the four reasons given above. At the same time, this alternative model also provides a rationale for explaining how capital can flow out of capital poor countries and into the rest of the world, or into capital rich countries and out of the rest of the world. For a country to be able to import capital from the rest of the world, it must have a supply of bonds available for sale. If all of its bonds are fully subscribed — that is, all reasonably profitable investment opportunities have been invested in, and only the risky or unprofitable investments remain — then that country will be unable to either import capital from the rest of the world, or to retain any increase in domestic saving as domestic investment. The expected return on bonds sold by firms in individual countries will also determine whether a country imports or exports capital on net. Taking two countries for which everything but the expected return on their bonds is identical, this alternative model predicts that the country with the higher expected return is more likely to import capital than the country with the lower expected return. Since the supply of reasonably profitable bonds is also linked to the expected return on bonds, the ability of a country to both attract foreign investment and retain domestic saving depends on the variables that the neo-classical model associates with different production technologies, and through them, expected rates of return.

This is consistent with the discussion on conditional convergence in the earlier chapters — rich countries may have more capital per capita than poor countries, but if they also have a superior production technology to poor countries, then the marginal return on capital in rich countries is not necessarily lower than in poor countries. Raising the rate of saving at low levels of income may not by itself be enough to lift that country out of poverty. An increase in the rate of saving in home country H will not fully register as an increase in the rate of investment in home country H unless there is a corresponding

increase in the supply of bonds offered by country *H*'s firms. If there is nothing left for investors to invest in, or if the risk associated with investment is too high, then the rate of investment in a poor country will not rise in line with an increase in the rate of saving. Inflows of foreign aid or foreign investment may simply crowd out the investment that would have been funded out of domestic saving, so that the capital imported via foreign aid and investment is off-set by the capital exported via the diverted domestic saving. Once again, this comes down to what drives the expected rate of return on investment, and the supply of investment opportunities, in different countries.

This in turn is consistent with the empirical work in relation to economic growth accelerations and a country's escape from a low-level equilibrium onto a path of sustained growth. For example, rather than using a cross-country growth regression, Martina (2007) examined the variables common to China, Vietnam, Malaysia, South Korea and Taiwan — all countries that had demonstrated sustained economic growth over the fifty year period covered by the Penn World Tables. He found that in all of these countries, increases in the rate of saving were accompanied by institutional reforms, and improvements to the quality of health, both of which laid the foundation for the sustained growth in these countries (Martina, 2009, p. 42). Interpreted within the context of this alternative model, institutional reforms would directly affect the production technology, through a combination of reducing the riskiness associated with investments, defining and enforcing property rights, and improving the incentives for manufacturers and exporters — all of which are things that would increase the amount of output that could be generated for a given amount of capital and labour. At the same time, improvements to health would reduce the morbidity rate, and increase the availability of labour, which would in turn increase the marginal return on capital. And improvements to health would also have positive implications for mortality, which in turn would alter the incentives for households to save and to accumulate human capital. In this way, this alternative model predicts that the combination of increased saving, and improvements to health and institutional quality, will lead to a higher rate of investment.

Martina's work used an approach similar to the one used by Hausmann et. al. (2005), in which the authors identified and analysed growth accelerations in countries. They defined a growth acceleration as 'an increase in per-capita growth of 2 percentage points or more (with most of the episodes we identify exceeding this threshold by a wide margin)...[where]...the increase in growth...[was]...sustained for at least eight years and the post-acceleration growth rate...[was]... at least 3.5 percent per year' (Hausmann et al., 2005, p. 305). The authors then sought to establish what caused a growth acceleration, and more importantly, what sustained a growth acceleration. Population health was not one of the variables considered in the analysis, but the authors tested variables that controlled for policy changes (for example, economic freedom, political coups and civil wars), as well as measures of economic and financial market performance (for example, trade, openness, exchange rate movements, financial market liberalisation). Overall, the authors concluded that while the data showed that growth accelerations occurred relatively frequently, their occurrence was difficult to predict, but that external shocks (captured by the movement in the terms of trade) were associated with unsustained growth accelerations, while economic reforms were associated with sustained growth accelerations.

Interpreted within the context of this alternative model, Hausmann et al.'s results imply that a positive external shock that is a windfall gain in income does not necessarily affect the production technology or the availability of labour and capital. Such a windfall gain may lead to an increase in the rate of saving, and even an increase in the rate of investment if the windfall can be used to finance economic activities that make use of labour that is unemployed or underemployed. In the absence of a corresponding improvement in production technology or an increase to the supply of investment opportunities within the same country, however, there is a limit to the extent to which the rate of investment can increase, and as a result, the country will fall back toward its low-level equilibrium. Economic reforms (using a measure that controls for the openness of the economy, the presence of marketing boards, macroeconomic stability, and barriers to international trade) will have the same impact on expected rates of return, and on the supply of bonds, as the improvements to institutional quality discussed above — both of them being things that will alter the

production technology, and increase the number of investments warranting an investor's consideration.

It is surprising, however, that Hausmann et. al. do not find any evidence of political regime changes and financial market liberalisation being associated with sustained growth accelerations, given that positive changes in both of these things would be reflected in this alternative model in the same way as the economic reforms. As discussed in chapter 1, Easterly (2005) links escapes from poverty traps with improvements to institutional quality as measured using indicators from the Polity IV database. In earlier work, Devarajan, Easterly and Pack (2003) examined the failure of sub-Saharan African countries to sustain economic growth, noting that investment in these countries accounted for around 10 % of GDP compared to 16 % in other developing countries (Devarajan et al., 2003, p. 547), and argued that 'unless some or all of the underlying factors that made investment unproductive in the past are addressed, the results [of an investment boom] may be disappointing. We should also be more circumspect about Africa's low savings rate. Perhaps the low savings rate was caused by the fact that the returns to investment were so low. And the relatively high level of capital flight from Africa may have been a rational response to the lack of investment opportunities at home' (Devarajan et al., 2003, p. 568). This conjecture ties directly to the alternative model presented in this chapter, since it highlights the need for matching increased saving with an increased supply of productive, reasonably profitable investments that that saving can be targeted at.

More recently, this is exactly what has been observed in certain African economies. Six of the ten economies that grew fastest between 2001 and 2010 are those of African countries — Angola, Nigeria, Ethiopia, Chad, Mozambique and Rwanda — and seven of the top ten economies expected to grow fastest between 2011 and 2015 are also those of African countries — Ethiopia, Mozambique, Tanzania, the Democratic Republic of Congo, Ghana, Zambia and Nigeria (The Economist, 2011a). Part of this rapid growth can be attributed to the boom in commodity prices — particularly since many of these countries have reserves of commodities such as oil (Nigeria), copper (Zambia), aluminium (Mozambique), and diamonds (Democratic Republic of Congo). A recent survey of these countries noted, however, that growth rates for African countries did

not fall when commodity prices suffered a setback in 2008 as would be expected from Devarajan et. al.'s findings. Instead, growth in African incomes and growth in foreign direct investment into Africa — which has overtaken foreign aid to Africa and nearly quintupled between 2000 and 2010 — was attributed to the uptake of technology and to political stability. The survey directly linked the take up of new technologies to improvements in health outcomes such as reductions in the rate of infection and increases in the number of people receiving effective treatment (The Economist, 2011b).

This in turn complements the wealth of evidence in the growth literature on conditional convergence. Improvements in health lead to a labour force that is more productive, because less time is spent being afflicted by or recovering from illness. They also increase the incentives to households of human capital accumulation (Chakraborty, 2004), which further improves the productivity of the labour force by increasing the skill of the average worker. Higher stocks of human capital accumulation are also associated with an improved ability to absorb new technologies or innovations (Benhabib and Spiegel, 1994), as well as leading to improvements in institutional quality (Glaeser et al., 2007). Improvements in both health and in stocks of human capital have the effect of increasing the bond supply in this alternative model, because they improve the production technology and increase the expected return on capital. When it comes to institutional quality, improvements in this regard not only alter the production technology, but can also reduce the risk associated with investing in particular countries.

4.4 CONCLUSION

This chapter uses the gravity equation with border effects to form a rationale for why countries import or export capital on net. In addition to the level and rate of saving, consideration is given to expected rates of return, cross-border distortions, and country-specific effects that drive the rate of long-run growth. Unfortunately in all of this, the major implication for poor countries is that the variables that this alternative model links to attracting and retaining investment are the same variables that are used to control for cross-country differences in production technologies when testing for conditional convergence. These variables — health, education, institutional quality —

are treated as exogenous in this alternative model. As discussed in chapter 1, if these variables are different at different levels of income, then they can generate multiple equilibria. When this is the case, the saving trap is not the only barrier to growth that a poor country might face. As shown in chapter 3, capital is internationally mobile and the variation in the rate of saving no longer accounts for all of the variation in the rate of investment across countries. By undertaking the same regression analysis as in chapter 3, but this time including controls for differences in expected rates of return on investment, the supply of bonds and iceberg costs across countries, it is possible to answer the following question: is the rate of investment in poor countries low because the rate of saving is low, or because poor countries do not have as many profitable economic activities for households to invest in? This is done in the next chapter.

5 TESTING THE ALTERNATIVE MODEL

5.1 INTRODUCTION

Chapter 1 summarised neo-classical growth theory and described the simple saving trap as being one of a number of types of barriers to growth. Chapter 2 set out the contradiction between the theory and the evidence on international capital movements that comprised Feldstein and Horioka's Puzzle, which the literature has not resolved. Chapter 3 presented new evidence on the Puzzle, showing that it has not characterised the investment and saving choices of OECD countries since the mid-1990s, and that it has never characterised the investment and saving choices of developing countries in the period studied. Chapter 4 drew on the international trade literature to develop an alternative model to motivate international capital flows.

This chapter tests that alternative model. The purpose of the test is to establish the following three things. The first is the extent to which the additional variables — the controls for rates of return, the supply of bonds and iceberg costs — are statistically significant in explaining the variation in the rate of investment across countries. The second is the extent to which the inclusion of these additional variables affects the coefficient on the rate of saving. Taken together, these first two things will establish the third — is the rate of investment in poor countries low because these countries are poor, or because richer countries offer relatively more attractive prospects for investment?

The rest of this chapter is split into five sections. The first unpacks the alternative model, and discusses the assumptions under which it is tested and the variables used. The second section presents the results of a purely cross-sectional regression analysis. The third section uses panel analysis to control for country fixed effects that may not have been identified in the alternative model, or adequately controlled for in the cross-sectional analysis. The fourth section discusses the implications of the findings, and the fifth summarises and concludes.

5.2 UNPACKING THE ALTERNATIVE MODEL

In the alternative model described in chapter 4, a country's rate of investment is determined based on rates of saving, the supply of bonds, expected rates of return, and the iceberg costs that erode rates of return across borders. Tests of the gravity equation generally involve datasets of bilateral flows and differences in distance or costs between pairs of countries. In the alternative model shown in chapter 4, each country has only one trading partner, which is defined as the rest of the world. As a result, in the test of the alternative model it is only necessary to control for variables specific to each country, rather than pairs of variables specific to each country and each of its multiple trading partners. Table 5.1 summarises each of the pieces of the alternative model, the data that will be used to test additional variables, the codes given to the variables in the regression analysis, and — in brackets — the expected sign on the coefficient.

If differences in these variables across countries are controlled for, and a country's rate of saving is strongly positively correlated with its rate of investment, then the saving trap is still a significant barrier to growth faced by today's poor countries. Conversely, if cross-country differences in production technologies are controlled for and the correlation between countries' rates of saving and investment remain small or statistically insignificant, then it implies that the saving trap is not a barrier to growth.

TABLE 5.1 VARIABLES IN THE ALTERNATIVE MODEL

	Name	Data	Code
s_R	Rate of saving, made up of:	• Rate of saving	• *SRATE (+)*
S_R	Level of saving	• Gross national saving • Gross domestic saving	• *Not used* • *Not used*
Y_R	Production / Income	• GDP per capita • GNI per capita • Foreign aid as a proportion of GNI	• *Not used* • *Not used* • *AID_GNI (-)*
p_R	Price of (or inverse return on) bonds	• Capital to labour ratio • Under 5 mortality rate • Labour force with no formal schooling	• *KPERLA (-)* • *MR5 (-)* • *LU (-)*
ϑ_R	Supply of bonds	• Price of capital goods relative to consumption goods • Property rights and law enforcement • Access to sound money	• *PRICE (-)* • *EFW_PR (+)* • *EFW_ES (+)*
T_{FR}/T_{RF}	Iceberg costs	• Openness	• *OPENC*

Note: Sign in brackets is the expected sign on the coefficient when the variable is regressed.

The additional variables identified in the alternative model are grouped into three broad categories shown in Table 5.1: variables that control for 'affordability', or the ability of countries to afford to invest domestically; variables that control for 'availability', or that determine the prospects for investment in a country and that country's ability to attract and retain investment; and 'capital mobility' variables that control for economic openness. Affordability is reflected using the rate of saving and the receipt of foreign aid. Cross-country differences in the availability of investments cannot be directly measured, however, it is possible to control for differences in expected rates of return and the supply of bonds across countries. This is done by controlling for the variables that explain differences in the price of capital goods, differences in production technologies across countries — such as health, education and institutional quality — and differences in countries' distances from steady state — such as their capital-to-labour ratios. Finally, while it is not possible in this analysis to distinguish iceberg costs that affect inflows of capital from those that affect outflows of capital, overall iceberg costs can be controlled for more generally by using information about a country's economic openness.

5.2.1 AFFORDABILITY

TABLE 5.2 VARIABLES IN THE ALTERNATIVE MODEL — AFFORDABILITY

	Name	Data	Code
s_{it}	Rate of saving, made up of:	• Rate of saving	• *SRATE (+)*
S_{it}	Level of saving	• Gross national saving • Gross domestic saving	• *Not used* • *Not used*
Y_{it}	Production / Income	• GDP per capita • GNI per capita • Foreign aid as a proportion of GNI	• *Not used* • *Not used* • *AID_GNI (-)*

Note: Sign in brackets is the expected sign on the coefficient when the variable is regressed.

This is the crux of the test of the saving trap — if poor countries had more income, would it be invested in their stock of physical capital ? The variables that fall under the category of 'affordability' attempt to control for cross-country differences in the extent to which the average household can afford investment. Income and production are not directly used in the analysis, as was done in Chapter 3. Instead, affordability is controlled for using saving as a rate of income or production, and the receipt of foreign aid as a proportion of income. It may appear counterintuitive for the expected sign on

foreign aid to be negative as in Table 5.2, however, the discussion of the alternative model in section 4.3.2 set out how a windfall increase in income, without a corresponding increase in the level of saving or improvement in the production technology, could lower the rates of both saving and investment.

Aside from measurement error, from a national accounting perspective, a country's saving can only be invested. The question left to answer is how much of that saving is invested domestically, and how much in the rest of the world. A country's income, on the other hand, can be invested domestically or overseas, or can be consumed as expenditure on food or clothing, or investment in education or health.[46] This means that the failure of an increase in the level of income to carry through to the level of investment does not mean that a country is not caught in a saving trap. As with income more generally, foreign aid may also be used to fund domestic investment directly, or it may be allocated toward consumption. This means that an inflow of foreign aid may not be reflected in an increase in the rate of investment if expenditure on shelter, food or medicine is more pressing — as a result, the inclusion of a variable for foreign aid cannot by itself test for the existence of a saving trap.

Interpreting the coefficient on the rate of saving is a more intuitively appealing test of the saving trap, because the rate of saving is the total budget that is available to be invested in physical capital — either domestically, or in the rest of the world. If an increase in a country's rate of saving were fully captured as an increase in that country's rate of investment — and other cross-country differences are controlled for — then this makes a strong case in favour of the savings trap. If this is not the case, then the shortfall must be due to some of that saving being invested in the rest of the world — it cannot have been spent on consumption or human capital.

[46] Expenditure on health and education is classified as consumption in the national accounts.

5.2.2 AVAILABILITY

TABLE 5.3 VARIABLES IN THE ALTERNATIVE MODEL — AVAILABILITY

	Name	Data	Code
p_N	Price of (or inverse return on) bonds	• Capital to labour ratio	• *KPERLA (-)*
		• Under 5 mortality rate	• *MR5 (-)*
ϑ_N	Supply of bonds	• Labour force with no formal schooling	• *LU (-)*
		• Price of capital goods relative to consumption goods	• *PRICE (-)*
		• Property rights and law enforcement	• *EFW_PR (+)*
		• Access to sound money	• *EFW_ES (+)*

Note: Sign in brackets is the expected sign on the coefficient when the variable is regressed.

The amount of investment that is actually realised in each period can be directly observed, but the total supply of potential investment opportunities cannot. After all, when attempting to establish whether rates of investment in poor countries are low because the rate of saving is low, or because there are insufficiently profitable projects to invest in, it is necessary to include variables that reflect the availability of investment opportunities across countries. As Table 5.3 shows, differences in the supply of, and the expected return on, domestic investment will be controlled for by using variables that reflect cross-country differences in the relative price of capital goods (*PRICE*), distance from steady state (*KPERLA*),[47] and production technologies (all other variables in Table 5.3). As the alternative model assumed, if the average expected rate of return across firms rises — due to an improvement in the production technology, an increase in the amount of available labour, or a reduction in the riskiness of doing business in a country — then that country's supply of investment opportunities also increases, as there are now a larger number of firms that are able to offer bonds with expected returns that are greater than or equal to the minimum that an investor will accept.

Country's stocks of human capital are reflected using the proportion of the labour force that has no formal education (*LU*) from Barro and Lee's dataset (2001) — countries with a higher proportion of labour with no formal education are expected to attract and retain less investment than countries with a lower. An equally important measure of human capital is health, rather than education, human capital, which is controlled

[47] The way in which the capital to labour ratios are derived is discussed in detail in the appendix to this chapter.

for using the under-five mortality rate (*MR5*) and is defined as 'the probability per 1,000 that a newborn baby will die before reaching age five, if subject to current age-specific mortality rates' (The World Bank, 2009). The higher the mortality rate, the poorer a country's health outcomes and so the less investment that country is expected to attract or retain. As a result, the rate of infant mortality is expected to be negatively correlated with the rate of investment measured both as a proportion of GDP and GNI.

Both production technology and the return on investment are also affected by institutional quality, as these variables affect the riskiness of doing business in a country. Importantly, these distortions are not the same as iceberg costs, even though they may erode the return on capital. This is because iceberg costs disproportionately affect cross-border transactions, whereas the distortions caused by political and economic risk will generally erode the return on investment for domestic and foreign investors equally. All other things being equal, countries with better economic and political stability, should have relatively superior production technologies, which should see them importing capital on net.

The analysis in this chapter uses indices of economic freedom that focus on the extent to which markets are constrained. These variables are taken from the Fraser Institute's *Economic Freedom of the World* index (Gwartney et al., 2009), where 'economic freedom' is defined as existing when '...property [that individuals] acquire without the use of force, fraud, or theft is protected from physical invasions by others and they are free to use, exchange, or give their property as long as their actions do not violate the identical rights of others. An index of economic freedom should measure the extent to which rightly acquired property is protected and individuals are engaged in voluntary transactions' (Gwartney et al., 2006). 'Property rights and law enforcement' (*EFW_PR*) is a measure of how stable and consistent a country's legal infrastructure is. 'Access to sound money' reflects rates of inflation and the volatility of these rates, and is an index of economic stability (*EFW_ES*). Both of these measures reflect the risks — political and economic — of investing in individual countries, with higher levels of risk affecting the expected return on investment and through it, the supply of profitable investments. The indices are compiled so that a higher number indicates greater economic freedom. Superior institutional quality is expected to be positively correlated with the rate of

investment, however, these measures of economic freedom also reflect the extent to which capital is mobile. As a result, their impact on the rate of investment in the analysis varies. More detail on the indices used is provided in the appendix to this chapter.

5.2.3 CAPITAL MOBILITY

TABLE 5.4 VARIABLES IN THE ALTERNATIVE MODEL — CAPITAL MOBILITY

	Name	Data	Code
T_{FH}/T_{HF}	Iceberg costs	• Openness	• *OPENC*

Note: Sign in brackets is the expected sign on the coefficient when the variable is regressed.

The third category of variables to control for is the one that reflect cross-country differences in capital mobility. Between them, the affordability and availability of domestic investment control for the total pool of income that is available for investment, and the total supply of investment opportunities. The final aspect of the alternative model is the iceberg costs that make cross border transactions more expensive than similar transactions conducted within a country. Ideally, the dataset would contain variables that distinguished restrictions on inflows of foreign capital from restrictions on outflows of domestic capital. This is, after all, the way iceberg costs are characterised in the alternative model — T_{FH} reflects the increased cost to domestic households, and is positively correlated with the rate of investment, while T_{HF} is the increased cost to foreign households, and is negatively correlated with the rate of investment. Data on capital restrictions, however, generally reflect the extent to which capital restrictions apply to financial instruments overall, without distinguishing restrictions on inflows from restrictions on outflows.

A measure of overall 'capital market restrictions' can be used in place of the two sorts of iceberg costs, however, it complicates the interpretation of the estimated coefficient. This is because two countries can have the same, low (relative to the rest of the world) marginal product of capital and the same rate of saving as one another, but a country with capital market restrictions will retain more of its saving and therefore have a higher rate of investment than the country without the capital market restrictions, which will experience capital flight. Under these circumstances, the estimated coefficient on economic openness can be expected to be negative — a country's rate of

investment is larger under a more restricted capital market. Conversely, if two countries have the same, high (relative to the rest of the world) marginal product of capital and the same rate of saving as one another, and one has capital restrictions and the other does not, then the country that has capital restriction will have a lower rate of investment, because it is unable to import as much capital from the rest of the world as the country with the unrestricted capital market. Under *these* circumstances, the estimated coefficient should be positive, since a more open economy means more investment flowing to where it is most profitable.

A commonly used measure of the openness of the economy is derived as the sum of the absolute value of its exports and imports as a proportion of its GDP (*OPENC*). This measure is generally more relevant to a consideration of restrictions on the international trade in goods than restrictions on the international flow of capital. That said, using this measure allows more countries to be included in the analysis, compared to an indicator like the Economic Freedom of the World's index of 'freedom to trade internationally', which is only available for 12 non-OECD countries in the period under analysis. Assuming that a country that has restrictions on the international trade of goods is also likely to have restrictions on capital flows — and that the differences across countries are roughly proportional — then this measure of openness is a reasonable proxy for international capital market freedom.[51]

5.3 THE PREFERRED MODEL

This section analyses the impact of the variables described using least squares regression, according to the following specification (where $\bar{Z}_i$ is a vector of the variables that will be used to control for differences across countries other than their rates of saving):

(5.1) $$IRATE_i = \delta + \beta_1 SRATE_i + \bar{\beta}_2 \bar{Z}_i$$

[51] Feldstein and Horioka used this measure of openness to test whether 'small economies that engage in substantial international trade will have a much weaker link between domestic saving and domestic investment than large and nearly autarchic economies' (Feldstein and Horioka, 1980).

The analysis is done using data for 1980 and 2000, as these were the years that were furthest apart from another that also have a reasonable number of countries with the necessary data. As the analysis will show, including one or more of the variables in Table 5.1 in $\overline{Z}_i$ affects neither the magnitude nor the statistical significance of β_1, the coefficient on the rate of saving. This is the case regardless of whether the analysis is done for 1980 or 2000, whether the sample includes or excludes the OECD countries, or whether rates of investment and saving are calculated as proportions of GDP or GNI. The consistent positive, statistically significant estimate of β_1 under these various specifications is strong evidence that a low rate of saving in poor countries can partially explain low rates of investment in these countries. It is not the only barrier to growth, however, because β_1 is never equal to or close to one. The evidence is presented in Table 5.6 through to Table 5.11 — Table 5.6 to Table 5.8 consist of estimates using data for the sample of all countries, with rates calculated as proportions of GDP and GNI respectively. Table 5.9. to Table 5.11 do the same for a sample of countries that excludes the OECD countries.

Where domestic rates of investment and saving are analysed, there are ten sets of regressions, with the first five using data for 1980, and the last five using data for 2000. The first regression for each year (I) shows estimates for the specification shown in equation (2.15), where $\overline{Z}_i$ is empty, and the rate of saving is the only explanatory variable. The sample of countries in the first regression is restricted to allow direct comparison of results between it and the estimates generated by the second regression (II), which is the preferred model. In this second regression, $\overline{Z}_i$ includes the variables shown in Table 5.5 (other than *SRATE*). The preferred model is limited to controls for the 'deep determinants' of growth — health, and institutions — and an additional control on affordability — receipt of foreign aid as a proportion of GNI.

TABLE 5.5 VARIABLES IN THE PREFERRED MODEL

	Name	Data	Code
s_N	Rate of saving	• Rate of saving	• *SRATE (+)*
Y_N		• Foreign aid as a proportion of GNI	• *AID_GNI (-)*
p_N	Price of (or inverse return on) bonds	• Under 5 mortality rate • Property rights and law enforcement • Access to sound money	• *MR5 (-)* • *EFW_PR (+)* • *EFW_ES (+)*
ϑ_N	Supply of bonds		

Note: Sign in brackets is the expected sign on the coefficient when the variable is regressed.

The fourth regression (IV) for each year shows the output for the 'expanded model', where $\overline{Z}_i$ includes all of the variables set out in Table 5.1 (other than *SRATE*). As the results for the joint *F*-test will show, these additional variables do not have sufficient additional explanatory power, and are dropped from the preferred model. The third regression (III) excludes all variables but the rate of saving, where the sample is restricted to only those countries that are included in the expanded specification. Once again, this is done so that any differences in the estimated coefficient on the rate of saving, or the R^2 coefficients can be attributed solely to differences in the specification, and not to which countries are in or out of the sample.

The fifth regression (V) uses the same sample of countries as the third and fourth regressions, and includes variables that control for interactions between the most statistically significant of the variables in Table 5.1. The sixth column (VI) does not contain additional regression output, but contains estimates of the overall impact of a variable on the rate of saving, which is the sum of its estimated and — where applicable — is interacted coefficients, multiplied by the simple mean value of the variables it is interacted with. This allows the coefficients generated in the fifth regression to be compared against the coefficients estimated in the second and fourth regressions.

For the analysis of national rates of investment and saving, only regressions I to IV are analysed for 1980 and 2000. This is because the output from these regressions fails to reject the Ramsey regression equation specification error test at the 10 % confidence level. This means that the preferred model is appropriately specified for an analysis of national rates of saving and investment, and that interactions between variables need not be controlled for. This is true of both the sample that includes all countries, and the sample that is limited to non-OECD countries. This is not surprising, since the analysis in chapter 3 demonstrated that countries' rates of national saving and investment were generally more closely correlated than their rates of domestic saving and investment. This can be explained by the fact that GNI is more likely to reflect a windfall income gain or terms of trade shock that will simply alter the denominator used to generate rates of national investment and saving, and move them both in the same direction. By contrast, a change in GDP will be associated with a change in production technology

that will be reflected in the other variables included in the analysis, and their interactions with one another.

5.3.1 ALL COUNTRIES

The analysis shows that β_1 is consistently higher when estimated using rates of national saving than when using rates of domestic saving, and declines in both magnitude and statistical significance between 1980 and 2000. The inclusion of the additional variables does not have a significant impact on either the magnitude or the statistical significance of β_1, however, the regressions that contain the additional variables have a higher adjusted R^2. In summary, the evidence in Table 5.6 to Table 5.8 implies that the rate of investment across all countries is not as affected by considerations of affordability in 2000 as it was in 1980. This is demonstrated by the coefficient estimates on the rate of saving and foreign aid as a proportion of GNI being halved between 1980 and 2000. Nevertheless, the coefficient estimates on the rates of saving, and on the receipt of foreign aid are positive and significant. This means that while there is still evidence that a country's low rate of saving as a result of low income is a barrier to growth, it is much weaker than in 2000 than it was in 1980.

In general, the additional variables had greater explanatory power in 2000 than in 1980, which demonstrates that simple affordability is a weakening barrier to growth. At the same time, not all of the additional variables are statistically significant. Contributions to the economic growth literature in recent years distinguish between 'proximate causes' of growth — that are directly linked with price distortions or the accumulation of factors — and 'deep determinants' of growth, which seek to go to the fundamental differences between countries that affect rates of growth. The growth literature characterises geography, institutional quality, and health outcomes as deep determinants of growth, of which only institutional quality and health can be affected by policy intervention. Geography is not directly included or tested in the cross-section analysis of the preferred model in section 5.3, however, section 5.4 controls for fixed effects, which indirectly controls for cross-country differences in geography.

TABLE 5.6 ALL COUNTRIES — RATES AS A PROPORTION OF GDP, 1980

	I	II	III	IV	V	VI
n	81	81	75	75	75	75
R^2	0.225	0.356	0.258	0.440	0.619	--
SRATE	0.262	0.334	0.330	0.385	0.386	0.554
	(4.93)	(5.44)	(5.17)	(4.96)	(1.83)	--
MR5	--	-0.019	--	-0.022	-0.023	-0.023
	--	(-1.53)	--	(-1.10)	(-1.33)	--
AID_GNI	--	0.676	--	0.650	0.479	0.479
	--	(3.66)	--	(3.31)	(2.39)	--
EFW_ES	--	0.403	--	0.490	2.403	0.188
	--	(1.16)	--	(1.44)	(3.16)	--
EFW_PR	--	0.753	--	0.991	0.433	0.691
	--	(1.70)	--	(2.03)	(0.36)	--
KPERLA	--	--	--	-0.021	0.001	0.001
	--	--	--	(-1.29)	(0.06)	--
LU	--	--	--	0.018	0.052	0.052
	--	--	--	(0.34)	(1.15)	--
OPENC	--	--	--	0.024	0.039	0.131
	--	--	--	(1.64)	(0.73)	--
PRICE	--	--	--	-0.448	-1.157	-1.157
	--	--	--	(-0.40)	(-1.18)	--
SRATExAID_GNI	--	--	--	--	0.017	--
	--	--	--	--	(1.55)	--
SRATExEFW_ES	--	--	--	--	--	--
	--	--	--	--	--	--
SRATExEFW_PR	--	--	--	--	0.088	--
	--	--	--	--	(2.43)	--
SRATExMR5	--	--	--	--	--	--
	--	--	--	--	--	--
EFW_ESxEFW_PR	--	--	--	--	-0.440	--
	--	--	--	--	(-3.01)	--
EFW_ESxMR5	--	--	--	--	--	--
	--	--	--	--	--	--
SRATExOPENC	--	--	--	--	-0.005	--
	--	--	--	--	(-3.38)	--
EFW_PRxOPENC	--	--	--	--	0.019	--
	--	--	--	--	(2.28)	--
CONSTANT	18.472	10.236	17.366	7.495	2.090	2.090
	(14.14)	(2.58)	(11.99)	(1.84)	(0.32)	--
F-prob 1	--	0.001	--	0.001	--	--
F-prob 2	--	0.073	--	0.266	--	--

Note: Figures in brackets are t-statistics. '*' indicates correction for heteroskedasticity. **F-prob 1** is the p-value for the test that all coefficients except for *SRATE* are zero. **F-prob 2** is the p-value for the test that *KPERLA=LU=OPENC=PRICE=0* for the full regression, and that *EFW_ES=EFW_PR=0* for the preferred regression.

TABLE 5.7 ALL COUNTRIES — RATES AS A PROPORTION OF GDP, 2000

	I	II	III	IV	V	VI
n	108	108	83	83	83	83
R^2	0.168	0.292	0.212	0.394	0.400	--
SRATE	0.186	0.149	0.210	0.192	-0.495	0.127
	(4.76)	(3.31)	(4.80)	(2.97)	(-1.86)	--
MR5	--	-0.043	--	-0.056	-0.228	-0.020
	--	(-3.24)	--	(-2.60)	(-4.13)	--
AID_GNI	--	0.218	--	0.288	0.598	0.208
	--	(1.81)	--	(2.09)	(3.30)	--
EFW_ES	--	0.740	--	0.829	-1.696	0.480
	--	(2.43)	--	(2.49)	(-1.80)	--
EFW_PR	--	-0.295	--	0.009	-0.465	-0.465
	--	(-0.81)	--	(0.02)	(-0.84)	--
KPERLA	--	--	--	-0.019	0.020	0.020
	--	--	--	(-0.97)	(0.91)	--
LU	--	--	--	0.045	0.049	0.049
	--	--	--	(1.00)	(1.10)	--
OPENC	--	--	--	0.011	0.015	0.015
	--	--	--	(0.92)	(1.26)	--
PRICE	--	--	--	0.336	-0.208	-0.208
	--	--	--	(0.76)	(-0.32)	--
SRATExAID_GNI	--	--	--	--	-0.019	--
	--	--	--	--	(-1.61)	--
SRATExEFW_ES	--	--	--	--	0.061	--
	--	--	--	--	(2.06)	--
SRATExEFW_PR	--	--	--	--	--	--
	--	--	--	--	--	--
SRATExMR5	--	--	--	--	0.004	--
	--	--	--	--	(3.06)	--
EFW_ESxEFW_PR	--	--	--	--	--	--
	--	--	--	--	--	--
EFW_ESxMR5	--	--			0.017	--
	--	--			(2.80)	--
SRATExOPENC	--	--	--	--	--	--
	--	--	--	--	--	--
EFW_PRxOPENC	--	--	--	--	--	--
	--	--	--	--	--	--
CONSTANT	17.554	16.096	17.135	11.445	36.372	36.372
	(18.83)	(5.46)	(16.30)	(2.78)	(4.13)	--
F-prob 1	--	0.000	--	0.002	--	--
F-prob 2	--	0.056	--	0.445	--	--

Note: Figures in brackets are t-statistics. '*' indicates correction for heteroskedasticity. **F-prob 1** is the p-value for the test that all coefficients except for *SRATE* are zero. **F-prob 2** is the p-value for the test that *KPERLA=LU=OPENC=PRICE=0* for the full regression, and that *EFW_ES=EFW_PR=0* for the preferred regression.

TABLE 5.8 ALL COUNTRIES — RATES AS A PROPORTION OF GNI

	1980	1980	1980	*1980	2000	2000	2000	*2000
	I	II	III	IV	I	II	III	IV
n	62	62	61	61	102	102	79	79
R^2	0.555	0.592	0.555	0.725	0.443	0.520	0.517	0.638
SRATE	0.596	0.654	0.596	0.586	0.358	0.337	0.377	0.362
	(8.78)	(7.27)	(8.70)	(6.24)	(9.02)	(7.53)	(9.19)	(5.94)
MR5	--	-0.014	--	-0.026	--	-0.039	--	-0.044
	--	(-1.15)	--	(-1.11)	--	(-3.38)	--	(-2.21)
AID_GNI	--	0.686	--	0.520	--	0.279	--	0.317
	--	(2.60)	--	(1.96)	--	(2.81)	--	(2.29)
EFW_3	--	0.242	--	0.378	--	0.572	--	0.480
	--	(0.76)	--	(1.30)	--	(2.21)	--	(1.81)
EFW_2	--	0.544	--	0.898	--	-0.282	--	0.165
	--	(1.25)	--	(1.98)	--	(-0.90)	--	(0.40)
KPERLA	--	--	--	-0.025	--	--	--	-0.029
	--	--	--	(-1.31)	--	--	--	(-1.82)
LU	--	--	--	-0.002	--	--	--	0.011
	--	--	--	(-0.03)	--	--	--	(0.29)
OPENC	--	--	--	0.035	--	--	--	0.014
	--	--	--	(3.91)	--	--	--	(1.82)
PRICE	--	--	--	2.083	--	--	--	0.288
	--	--	--	(1.80)	--	--	--	(0.80)
CONSTANT	12.885	6.791	12.876	2.923	14.784	13.757	14.261	10.866
	(9.10)	(1.83)	(9.01)	(0.78)	(15.96)	(5.40)	(14.54)	(3.83)
F-prob 1	--	0.062	--	0.000	--	0.001	--	0.005
F-prob 2	--	0.247	--	0.000	--	0.092	--	0.105

Note: Figures in brackets are t-statistics. '*' indicates correction for heteroskedasticity. **F-prob 1** is the p-value for the test that all coefficients except for *SRATE* are zero. **F-prob 2** is the p-value for the test that *KPERLA=LU=OPENC=PRICE=0* for the full regression, and that *EFW_ES=EFW_PR=0* for the preferred regression.

It is no surprise, then, that these deep determinants — such as the mortality rate, and both measures of institutional quality — have greater explanatory power than proximate causes of growth such as the capital-to-labour ratio, the relative price of capital goods or the stock of human capital. For this reason, the preferred model, tested down from the expanded model, retains health, property rights and access to sound money. Receipt of foreign aid is also retained as a control for affordability — while its relative importance has waned, it is still statistically significant in 2000. Across the data set, property rights had a greater impact in 1980 while access to sound money was relatively insignificant, but by 2000, the opposite was true. As a result, both measures

are included in the preferred specification, and the probability values for the *F*-tests show that they are jointly significant at the 10 % level, except in 1980 for rates of investment and saving calculated as proportions of GNI.

Finally, the 'deep determinants', along with the control for economic openness, have the greatest explanatory power when interacted with the controls for affordability and with one another. Regression V for the analysis of domestic rates of investment and saving includes selected interactions of the variables in the expanded model. The interpretation of the coefficients on the interacted variables is complicated because simply analysing the estimated coefficients implies that the average values of the other terms in the interaction are zero. For example, the estimated coefficient on *SRATE* in Table 5.7 is -0.495, which implies that the rate of investment will fall as the rate of saving increases. In fact, this would only be the case where the variables that *SRATE* is interacted with are equal to zero — that is, the receipt of foreign aid is zero, access to sound money is judged to be so lacking that it scores a zero, and there is no under-five mortality. Taking the average values of *AID_GNI*, *EFW_ES* and *MR5* across the sample, multiplying them by the estimated coefficient on the appropriate interacted terms and adding them to the estimated coefficient on *SRATE* gives the implied impact, evaluated for the average country in the sample, of 0.127. The sixth column in Table 5.6 and Table 5.7 (as well as in Table 5.9 and Table 5.10 below) shows the overall impact of a change in each variable on the rate of investment, calculated in the manner described. The proximate causes of growth, on the other hand, have little to no impact on either domestic or national rates of investment in either period.

5.3.2 NON-OECD COUNTRIES

Table 5.9 through to Table 5.11 show the effects of including the additional variables in cross-sections for 1980 and 2000 that exclude the OECD countries. The overall pattern is similar to the sample of all countries — the rate of saving is statistically significant in all instances, and the rate of national saving continues to have a higher estimated coefficient than the rate of domestic saving as was the case with the estimates in chapter 3.

TABLE 5.9 NON-OECD COUNTRIES — RATES AS A PROPORTION OF GDP, 1980

	I	II	III	IV	V	VI
n	58	58	53	53	53	53
R^2	0.206	0.417	0.226	0.438	0.568	--
SRATE	0.245	0.280	0.308	0.336	0.210	0.419
	(3.98)	(4.06)	(4.02)	(3.47)	(0.73)	--
MR5	--	-0.029	--	-0.019	-0.026	-0.026
	--	(-2.12)	--	(-0.78)	(-1.18)	--
AID_GNI	--	0.593	--	0.614	0.464	0.780
	--	(2.99)	--	(2.68)	(2.20)	--
EFW_ES	--	0.941	--	0.871	3.324	0.501
	--	(2.20)	--	(1.78)	(3.07)	--
EFW_PR	--	1.396	--	1.256	0.443	0.995
	--	(2.45)	--	(1.98)	(0.21)	--
KPERLA	--	--	--	-0.010	-0.007	-0.007
	--	--	--	(-0.20)	(-0.14)	--
LU	--	--	--	-0.012	0.027	0.027
	--	--	--	(-0.20)	(0.50)	--
OPENC	--	--	--	0.022	0.008	0.008
	--	--	--	(1.19)	(0.45)	--
PRICE	--	--	--	-0.350	-1.066	-1.066
	--	--	--	(-0.27)	(-0.90)	--
SRATExAID_GNI	--	--	--	--	0.017	--
	--	--	--	--	(1.24)	--
SRATExEFW_ES	--	--	--	--	-0.077	--
	--	--	--	--	(-1.60)	--
SRATExEFW_PR	--	--	--	--	0.139	--
	--	--	--	--	(3.06)	--
SRATExMR5	--	--	--	--	--	--
	--	--	--	--	--	--
EFW_ESxEFW_PR	--	--	--	--	-0.344	--
	--	--	--	--	(-1.09)	--
EFW_ESxMR5	--	--	--	--	--	--
	--	--	--	--	--	--
SRATExOPENC	--	--	--	--	--	--
	--	--	--	--	--	--
EFW_PRxOPENC	--	--	--	--	--	--
	--	--	--	--	--	--
CONSTANT	18.780	7.788	17.791	6.376	4.424	4.424
	(12.23)	(1.70)	(10.36)	(1.13)	(0.53)	--
F-prob 1	--	0.000	--	0.004	--	--
F-prob 2	--	0.007	--	0.819	--	--

Note: Figures in brackets are t-statistics. '*' indicates correction for heteroskedasticity. **F-prob 1** is the p-value for the test that all coefficients except for *SRATE* are zero. **F-prob 2** is the p-value for the test that *KPERLA=LU=OPENC=PRICE=0* for the full regression, and that *EFW_ES=EFW_PR=0* for the preferred regression.

The increase in the adjusted R^2 coefficient once again demonstrates that the additional variables do add to the explanation of what drives rates of investment across countries. With respect to the saving trap itself, there is strong evidence that rates of investment and saving in the non-OECD countries are still positively correlated in 2000, which means that at least part of an increase in a country's rate of saving will be retained as domestic investment. In addition, there is extremely strong evidence that the inclusion of the variables discussed so far does not significantly alter the estimate of β_1.

Both the preferred and the expanded model are estimated for the sample of non-OECD countries. One major difference is that cross-country differences in property rights and law enforcement have considerably more explanatory power across non-OECD countries in 2000 than when OECD countries were included in the sample. Repeating the joint F-tests for the coefficients on access to sound money and property rights and law enforcement, there is evidence to support the retention of both variables at a 1 % level of significance, compared to 10 % for the sample of all countries. In general, the controls for foreign aid, access to sound money, and property rights have a stronger effect on countries' rates of investment — both in terms of magnitude and statistical significance — when OECD countries are excluded from the sample. Access to sound money and property rights have a simple intuitive explanation, since they reflect the riskiness associated with investing in a particular country. Access to sound money is relatively unimportant as a driver of investment in 1980, but becomes more important in 2000. This is in contrast to the coefficient on property rights, which exhibits the opposite behaviour.

In addition, the estimated coefficient on the mortality rate almost doubles in magnitude, and becomes statistically significant in 2000. As discussed earlier, a healthier workforce can supply more hours of labour due to less time lost to recovering from illness, or taking care of family members who are ill. A healthier population also increases life expectancy, and through it, the incentive to invest in human capital. Martina (2009) makes a strong argument for the importance of improved health outcomes to growth in incomes, highlighting the cases of China, Taiwan, South Korea, Malaysia and Vietnam, where declines in the rate of infant and under-five mortality preceded sustained accelerations in the rate of economic growth.

TABLE 5.10 NON-OECD COUNTRIES — RATES AS A PROPORTION OF GDP, 2000

	I	II	III	IV	V	VI
n	92	92	67	67	67	67
R^2	0.178	0.351	0.231	0.416	0.404	--
SRATE	0.193	0.161	0.222	0.209	-0.550	0.145
	(4.56)	(3.27)	(4.56)	(3.31)	(-1.83)	--
MR5	--	-0.040	--	-0.052	-0.247	-0.027
	--	(-2.85)	--	(-2.37)	(-3.76)	--
AID_GNI	--	0.228	--	0.296	0.602	0.219
	--	(2.15)	--	(2.05)	(3.04)	--
EFW_ES	--	0.817	--	0.860	-2.182	0.496
	--	(3.16)	--	(2.49)	(-1.90)	--
EFW_PR	--	0.192	--	0.070	-0.541	-0.541
	--	(0.48)	--	(0.12)	(-0.80)	--
KPERLA	--	--	--	-0.020	0.018	0.018
	--	--	--	(-0.56)	(0.52)	--
LU	--	--	--	0.040	0.050	0.050
	--	--	--	(0.91)	(1.02)	--
OPENC	--	--	--	0.010	0.019	0.019
	--	--	--	(0.75)	(1.23)	--
PRICE	--	--	--	0.420	-0.151	-0.151
	--	--	--	(0.93)	(-0.21)	--
SRATExAID_GNI	--	--	--	--	-0.020	--
	--	--	--	--	(-1.50)	--
SRATExEFW_ES	--	--	--	--	0.070	--
	--	--	--	--	(2.10)	--
SRATExEFW_PR	--	--	--	--	--	--
	--	--	--	--	--	--
SRATExMR5	--	--	--	--	0.004	--
	--	--	--	--	(2.73)	--
EFW_ESxEFW_PR	--	--	--	--	--	--
	--	--	--	--	--	--
EFW_ESxMR5	--	--	--	--	0.020	--
	--	--	--	--	(2.73)	--
SRATExOPENC	--	--	--	--	--	--
	--	--	--	--	--	--
EFW_PRxOPENC	--	--	--	--	--	--
	--	--	--	--	--	--
CONSTANT	17.294	12.707	16.775	9.909	39.509	39.509
	(17.18)	(3.74)	(14.45)	(2.28)	(3.70)	--
F-prob 1	--	0.000	--	0.009	--	--
F-prob 2	--	0.005	--	0.552	--	--

Note: Figures in brackets are t-statistics. '*' indicates correction for heteroskedasticity. **F-prob 1** is the p-value for the test that all coefficients except for *SRATE* are zero. **F-prob 2** is the p-value for the test that *KPERLA=LU=OPENC=PRICE=0* for the full regression, and that *EFW_ES=EFW_PR=0* for the preferred regression.

Including interacted variables in the analysis does not alter the overall finding. The impact of these variables, when evaluated for the average country in the sample at the average, is similar to the impacts estimated in the expanded model — both in 1980 and 2000. The two exceptions are the variables that control for differences in access to sound money and property rights, which have a smaller impact when interacted than on their own. Once again, the Ramsey regression equation specification error test fails to reject the null hypothesis that the analysis of national rates of investment and saving is correctly specified, and so coefficients for interacted variables are not estimated.

As with the full sample of countries above, the coefficient estimate on the receipt of aid is roughly halved between 1980 and 2000 — for rates of investment measured as proportions of both GDP and GNI. Excluding OECD countries from the sample does not significantly affect the coefficient estimates, but it does reduce the associated standard errors. This is unsurprising, since with the exception of Turkey, OECD countries do not receive foreign aid. The continued importance of aid and of the rate of saving in the regression analysis demonstrates that simple affordability is still a barrier to investment in the non-OECD countries. The increased significance of health and institutional quality in 2000 compared to 1980 demonstrates that addressing affordability alone is not a viable solution.

Once again, the variables controlling for differences in proximate causes of growth lack statistical significance, and a joint F-test for these variables supports excluding them from the preferred model for the non-OECD countries. The inclusion of the capital-to-labour ratio (*KPERLA*) is not statistically significant using data for either 1980 or 2000, which is consistent with the discussion on Lucas' and Caselli and Feyrer's work in section 2.4.2 — there is more to investment decisions than simply whether a country is capital-rich or capital-poor. The price of capital goods relative to consumption goods (*PRICE*) also does not appear to have any influence on countries' rates of investment, which appears peculiar, given Sala-i-Martin et. al.'s findings on the importance of this variable in explaining differences in rates of economic growth across countries (2004). It is, however, generally categorised as one of the proximate causes of growth, and is not included in the preferred model for this reason.

TABLE 5.11 NON-OECD COUNTRIES — RATES AS A PROPORTION OF GNI

	1980 I	1980 II	1980 III	1980 IV	2000 I	2000 II	2000 III	*2000 IV
n	41	41	40	40	86	86	63	63
R^2	0.548	0.697	0.547	0.736	0.493	0.600	0.592	0.702
SRATE	0.623	0.598	0.623	0.559	0.383	0.363	0.410	0.398
	(7.04)	(6.05)	(6.94)	(5.48)	(9.14)	(7.97)	(9.55)	(6.29)
MR5	--	-0.026	--	-0.020	--	-0.034	--	-0.037
	--	(-2.01)	--	(-0.84)	--	(-3.01)	--	(-1.77)
AID_GNI	--	0.653	--	0.565	--	0.293	--	0.336
	--	(2.41)	--	(2.08)	--	(2.98)	--	(2.25)
EFW_ES	--	0.855	--	0.807	--	0.640	--	0.415
	--	(2.24)	--	(1.96)	--	(2.41)	--	(1.43)
EFW_PR	--	1.594	--	1.689	--	0.492	--	0.184
	--	(3.01)	--	(2.93)	--	(1.23)	--	(0.38)
KPERLA	--	--	--	-0.030	--	--	--	-0.012
	--	--	--	(-0.59)	--	--	--	(-0.41)
LU	--	--	--	-0.050	--	--	--	0.004
	--	--	--	(-0.82)	--	--	--	(0.09)
OPENC	--	--	--	0.030	--	--	--	0.011
	--	--	--	(2.09)	--	--	--	(0.94)
PRICE	--	--	--	2.215	--	--	--	0.488
	--	--	--	(1.92)	--	--	--	(1.33)
CONSTANT	12.976	2.176	12.977	-0.514	14.341	8.743	13.645	9.419
	(7.59)	(0.53)	(7.48)	(-0.11)	(14.73)	(3.02)	(13.30)	(3.28)
F-prob 1	--	0.001	--	0.001	--	0.000	--	0.006
F-prob 2	--	0.002	--	0.093	--	0.011	--	0.450

Note: Figures in brackets are t-statistics. '*' indicates correction for heteroskedasticity. **F-prob 1** is the p-value for the test that all coefficients except for *SRATE* are zero. **F-prob 2** is the p-value for the test that *KPERLA=LU=OPENC=PRICE=0* for the full regression, and that *EFW_ES=EFW_PR=0* for the preferred regression.

Human capital in the form of education is one of the classic complementary factors of production to physical capital, however, the control for the proportion of the population that has not been formally educated is not significant in the analysis. This lack of explanatory power may be due in part to the fact that the Barro and Lee dataset used in this analysis does not control for differences in the quality of education received across different countries. In addition, Barro and Lee's own inclusion of educational attainment in their conditional convergence analysis generated counter-intuitive findings, with female educational attainment having a negative estimated coefficient. The authors noted the oddity, and suggested that lower

educational attainment was associated with 'backwardness', which in turn was associated with greater distance from a country's steady state — as a result, these countries had higher rates of growth (Barro and Lee, 1994). For both of these reasons, *LU* is excluded from the preferred model.

Interpreting the preferred model without the interacted variables, it seems that focussing on health outcomes is a better and more affordable proposition for attracting investment than tackling institutional quality. The indices of economic freedom are compiled to rate countries from zero to ten, for 123 countries in 2000. The mean and standard deviation are 7.6 and 1.9 respectively for access to sound money in 2000, and 5.8 and 1.9 for property rights and law enforcement. In order to increase the rate of investment by one percentage point, the average non-OECD country would need to improve its access to sound money score by between 1.2 and 2.4 index points depending on the measure of investment used. With respect to property rights, the average non-OECD country's score would need to increase by 2 to 15 index points to achieve the same one percentage point increase in the rate of investment in 2000. Noting that the highest score a country can have is 10, this demonstrates that property rights and law enforcement have a weaker economic significance as well as a weaker statistical significance compared to access to sound money.

Health, as measured by the under-five mortality rate, can be seen to have a significant impact on countries' rates of domestic and national investment in both years. The estimated coefficients are also roughly similar in magnitude when estimated using the different data sets, with the implication that in 2000, the average non-OECD country would need to reduce its under-five mortality rate from between 19 and 29 children a year, in order to generate a one percentage point increase in the rate of investment. Since the mean under-five mortality rate for non-OECD countries in 2000 was 68.6, and the standard deviation was 63.2, the improvement in health necessary to raise the rate of investment by one percentage point is considerably less than the standard deviation for this measure, and is far more reasonable to attain than the improvements to countries' economic freedom scores necessary to obtain the same effect.

5.4 CONTROLLING FOR FIXED EFFECTS

In addition to the variables analysed and discussed so far, there are a range of other variables that reflect cultural or religious differences across countries (for example, the proportion of the population that speaks a particular language, or follows a particular faith), or the geographic location of the country (for example, distance from the equator, or whether or not the country is landlocked). These differences have been shown to have strong explanatory power in cross-country economic growth regressions, but have so far been excluded from this analysis. Many of these differences are country fixed effects — for example, neither a country's distance from the equator nor the proportion of the population that speaks a particular language or follows a certain faith are likely to have changed significantly in the twenty year period analysed. Without meaning to downplay the importance of identifying these variables individually, the purpose of the analysis in this chapter is to identify the factors that affect rates of investment and that can also be affected by policy initiatives — such as country differences in institutional quality or health. Nevertheless, it is also necessary to establish that the exclusion of these fixed effects does not bias the estimates of the other variables.

Table 5.12 and Table 5.13 show the regression output for a fixed effects estimation of the relationship between rates of investment and saving, when measured as proportions of GDP and GNI, respectively.[52] This analysis shows that the results in the previous section were not biased by fixed effects. Rates of investment and saving are significantly and positively (although far from perfectly) correlated, the inclusion of additional variables affects neither the magnitude nor the significance of the coefficient on the rate of saving, and the additional variables contribute further explanatory power as evidenced by the increase in the within R^2 coefficient. The negative coefficient on the dummy variables for the different years (with 1980 being the default) indicate that the rate of investment across countries on average has declined between 1980 and

[52] The Ramsey regression equation specification error test fails to reject the null hypothesis that the analysis is correctly specified for all of the regression analysis in this section, and so coefficients for interacted variables are not estimated.

2000, for reasons other than those that can be accounted for by the fixed effects or the variables included. The country fixed effects themselves account for roughly half of the unexplained variation in cross-country rates of investment — something that is consistent across the country samples, and the different measures of rates of saving and investment.

There are also a number of clear differences. For the first time, the estimated coefficients on the rates of national saving are similar in magnitude to those using the rates of domestic saving — in all of the other analysis up until this point, the former have always been higher. The second major difference is that economic openness has a strong, positive impact on the rate of investment under all of the circumstances shown. The level of population health and the receipt of aid have far less explanatory power in the specification using rates of investment and saving as proportions of GNI than they do for rates of investment and saving as proportions of GDP, however, the magnitude of the coefficient estimates are similar to those generated in the cross-section analysis earlier. Controlling for fixed effects has no impact on the economic significance of access to sound money, however, the coefficient estimates are much more strongly statistically significant when fixed effects are controlled for. With respect to property rights and law enforcement, controlling for fixed effects practically decimates the coefficient estimate, while the statistical significance remains low.

TABLE 5.12 RATES AS A PROPORTION OF GDP, FIXED EFFECTS 1980-2000

	ALL	ALL	ALL	ALL	NON-OECD	NON-OECD	NON-OECD	NON-OECD
	I	II	III	IV	I	II	III	IV
n	490	490	410	410	389	389	311	311
Countries	117	117	92	92	93	93	69	69
R^2	0.205	0.264	0.213	0.309	0.174	0.246	0.186	0.305
ρ	0.521	0.616	0.504	0.589	0.537	0.555	0.545	0.548
SRATE	0.326	0.363	0.329	0.361	0.281	0.316	0.269	0.304
	(8.66)	(9.62)	(8.03)	(8.69)	(6.74)	(7.60)	(5.86)	(6.51)
MR5	--	-0.049	--	-0.055	--	-0.046	--	-0.047
	--	(-2.86)	--	(-3.09)	--	(-2.30)	--	(-2.35)
AID_GNI	--	0.124	--	0.121	--	0.107	--	0.091
	--	(2.51)	--	(2.05)	--	(2.07)	--	(1.46)
EFW_ES	--	0.649	--	0.692	--	0.731	--	0.749
	--	(4.43)	--	(4.40)	--	(4.50)	--	(4.26)
EFW_PR	--	0.076	--	0.216	--	0.055	--	0.253
	--	(0.30)	--	(0.80)	--	(0.20)	--	(0.85)
KPERLA	--	--	--	-0.019	--	--	--	-0.041
	--	--	--	(-0.90)	--	--	--	(-1.08)
LU	--	--	--	0.048	--	--	--	0.063
	--	--	--	(0.94)	--	--	--	(1.06)
OPENC	--	--	--	0.049	--	--	--	0.054
	--	--	--	(2.98)	--	--	--	(3.04)
PRICE	--	--	--	0.115	--	--	--	0.122
	--	--	--	(0.57)	--	--	--	(0.58)
1985	-1.897	-2.643	-2.376	-2.788	-2.115	-2.962	-2.772	-2.850
	(-2.76)	(-3.76)	(-3.4)	(-3.91)	(-2.53)	(-3.38)	(-3.22)	(-3.08)
1990	-1.383	-3.038	-1.796	-3.082	-1.413	-3.106	-1.904	-2.814
	(-2.09)	(-3.99)	(-2.65)	(-3.81)	(-1.74)	(-3.16)	(-2.27)	(-2.57)
1995	-1.795	-3.905	-1.828	-4.014	-1.294	-3.400	-1.120	-2.918
	(-2.71)	(-4.61)	(-2.68)	(-4.19)	(-1.62)	(-3.17)	(-1.34)	(-2.27)
2000	-2.826	-5.848	-2.843	-5.857	-2.735	-6.000	-2.744	-5.426
	(-4.22)	(-6.13)	(-4.09)	(-5.08)	(-3.43)	(-5.05)	(-3.28)	(-3.57)
CONSTANT	17.300	16.418	17.435	11.537	18.138	17.849	18.557	11.401
	(19.24)	(7.04)	(18.49)	(3.98)	(17.84)	(6.05)	(17.58)	(2.79)
F-prob 1	--	0.000	--	0.000	--	0.000	--	0.000
F-prob 2	--	0.000	--	0.017	--	0.000	--	0.011

Note: Figures in brackets are t-statistics.

ρ indicates the proportion of the unexplained variation in the rate of investment that is accounted for by the fixed effects.

The R^2 coefficient shown is the 'within' coefficient.

F-prob 1 is the p-value for the test that all coefficients except for *SRATE* and the year dummy variables are zero.

F-prob 2 is the p-value for the test that *KPERLA=LU=OPENC=PRICE=0* for the full regression, and that *EFW_ES=EFW_PR=0* for the preferred regression.

TABLE 5.13 RATES AS A PROPORTION OF GNI, FIXED EFFECTS 1980-2000

	ALL	ALL	ALL	ALL	NON-OECD	NON-OECD	NON-OECD	NON-OECD
	I	II	III	IV	I	II	III	IV
n	431	431	368	368	335	335	272	272
Countries	112	112	89	89	89	89	66	66
R^2	0.185	0.209	0.179	0.251	0.180	0.210	0.183	0.269
ρ	0.472	0.474	0.491	0.481	0.472	0.416	0.509	0.475
SRATE	0.326	0.330	0.291	0.271	0.322	0.326	0.283	0.267
	(7.17)	(7.22)	(6.15)	(5.66)	(6.30)	(6.33)	(5.23)	(4.90)
MR5	--	-0.034	--	-0.028	--	-0.029	--	-0.017
	--	(-1.64)	--	(-1.32)	--	(-1.15)	--	(-0.65)
AID_GNI	--	0.062	--	0.018	--	0.053	--	0.006
	--	(1.00)	--	(0.26)	--	(0.77)	--	(0.08)
EFW_ES	--	0.430	--	0.445	--	0.523	--	0.519
	--	(2.59)	--	(2.53)	--	(2.69)	--	(2.47)
EFW_PR	--	0.056	--	0.229	--	0.032	--	0.270
	--	(0.18)	--	(0.68)	--	(0.09)	--	(0.68)
KPERLA	--	--	--	-0.027	--	--	--	-0.062
	--	--	--	(-1.18)	--	--	--	(-1.33)
LU	--	--	--	0.017	--	--	--	0.047
	--	--	--	(0.28)	--	--	--	(0.61)
OPENC	--	--	--	0.069	--	--	--	0.069
	--	--	--	(3.55)	--	--	--	(3.12)
PRICE	--	--	--	0.187	--	--	--	0.192
	--	--	--	(0.88)	--	--	--	(0.82)
1985	-2.880	-3.339	-3.090	-3.156	-2.998	-3.505	-3.308	-2.831
	(-3.64)	(-4.07)	(-3.94)	(-3.92)	(-2.90)	(-3.15)	(-3.18)	(-2.51)
1990	-1.834	-2.892	-2.116	-2.692	-1.867	-2.922	-2.284	-2.276
	(-2.42)	(-3.30)	(-2.80)	(-3.00)	(-1.87)	(-2.37)	(-2.26)	(-1.74)
1995	-2.149	-3.494	-1.791	-3.096	-1.534	-2.811	-0.903	-1.530
	(-2.86)	(-3.64)	(-2.37)	(-2.94)	(-1.56)	(-2.12)	(-0.90)	(-1.01)
2000	-3.341	-5.364	-3.228	-5.246	-3.203	-5.388	-3.087	-4.320
	(-4.36)	(-4.92)	(-4.16)	(-4.08)	(-3.24)	(-3.63)	(-3.05)	(-2.35)
CONSTANT	18.488	18.480	19.070	13.683	18.566	18.663	19.233	11.286
	(18.07)	(6.73)	(18.00)	(4.13)	(15.88)	(5.00)	(15.94)	(2.19)
F-prob 1	--	0.051	--	0.002	--	0.065	--	0.006
F-prob 2	--	0.029	--	0.002	--	0.024	--	0.005

Note: Figures in brackets are t-statistics.

ρ indicates the proportion of the unexplained variation in the rate of investment that is accounted for by the fixed effects.

The R^2 coefficient shown is the 'within' coefficient.

F-prob 1 is the p-value for the test that all coefficients except for *SRATE* and the year dummy variables are zero.

F-prob 2 is the p-value for the test that *KPERLA=LU=OPENC=PRICE=0* for the full regression, and that *EFW_ES=EFW_PR=0* for the preferred regression.

5.5 IMPLICATIONS FOR DEVELOPING COUNTRIES

For the non-OECD countries, the relationship between countries' rates of saving and investment is positive and strongly statistically significant in 1980 and 2000 — both for national and domestic rates of saving. This, and the positive, statistically significant coefficient on the receipt of foreign aid, supports the argument that the low levels of investment in some developing countries are partly attributable to a lack of affordability among domestic households. This relationship has weakened between 1980 and 2000, although certainly not to the extent that it has across the sample of OECD countries over the same period. Chapter 3 showed that the relationship between rates of domestic saving and investment in the non-OECD countries was often statistically insignificant, however, the relationship between rates of *national* saving and investment was consistently positive and statistically significant, implying that on average, a non-OECD country would retain between one third to one half of national saving as investment locally.

It is tempting to conclude from this that rates of investment in developing countries can be improved through the provision of foreign aid or foreign investment. The correlation between rates of investment and saving in non-OECD countries is positive and statistically significant, but it is neither equal to nor close to one. Additionally, not only has the relationship between affordability and rates of investment weakened over time, but the variables that control for differences in the availability of investment have grown stronger over time. This can be attributed to countries growing more financially sophisticated, the costs of search and transactions associated with international capital movements falling, and developing countries engaging more closely with the global markets. This is a trend that is likely to continue, which means that efforts aimed at addressing the affordability of investment may be misguided and misplaced. Households in poorer countries may consume out of foreign aid and save more of their earned incomes, but if there are insufficient investment opportunities domestically, that increased saving will be exported. The same is true of foreign investment — an inflow of capital from the rest of the world may exhaust the investment opportunities that domestic saving would have funded, and in the absence of anything profitable to invest in, this saving is exported — if not by households themselves, then by the

financial intermediaries or brokers with whom households entrust their savings. The analysis implies that it is much cheaper and easier for poorer countries to export capital to the rest of the world in 2000 than it was in 1980.

Rates of investment in developing countries can be improved is by addressing the availability of investment opportunities. As the analysis in this chapter shows, the level of health and institutional quality have become more important to countries' rates of investment in 2000 than they were in 1980. There should be nothing surprising about this finding, since it is in line with the predictions of the neo-classical model, and with the empirical findings on the deep determinants of long-run growth — in particular, that of Easterly (2005) and Rodrik et. al. (2004) who argue that institutions rule; and that of Sachs (2005), Weil (2007), and Martina (2009), who demonstrate the devastating impact that adverse health outcomes across countries can have on economic performance. Furthermore, it is consistent with Lucas' conjecture that differences in the marginal products of capital across countries could not simply be explained by the capital to labour ratios of these countries, and that it is necessary to control for complementary inputs, and the riskiness associated with investing in different countries. This analysis provides strong evidence that the availability of investment opportunities has become, and is will continue to be, more important in explaining differences in countries' rates of investment than considerations of affordability, which have been in decline over the period analysed. This means that while there was once some evidence that the saving trap was a barrier to growth in incomes, there is less evidence for this in more recent years. Furthermore, the analysis using the alternative model provides support not only for capital being internationally mobile, but also for capital being efficiently allocated, as countries with better health and better institutional quality are shown to have higher rates of investment.

All of this suggests that today's poor countries are indeed confronted with a barrier to growth that today's rich countries did not have to overcome. Capital is internationally mobile, which means that today's poor countries must compete with today's rich countries for investment — not only with respect to attracting foreign investment, but also to simply retaining domestic or national saving. This is not to say that the solution is for developing countries to close their borders to outflows of capital, or attempt to

retain saving by artificial means as suggested by Caselli and Feyrer. Even if restrictions are placed to keep domestic saving inside a country, this can have the adverse effect of frightening foreign investment away. After all, foreign investors may have legitimate concerns as to whether or not they will be able to recover the return on their investment in such a restricted market. And as the analysis in this chapter shows, when fixed effects are controlled for, economic openness is positively correlated with the rate of investment. In addition, there is no guarantee that the imposition of capital restrictions will ensure that domestic saving is converted into domestic investment. Saving is merely the difference between what is earned and what is consumed. There are a number of ways in which households can save without investing either domestically or abroad — for example, through the purchase of jewellery or other stores of wealth, simply by hoarding currency, or by making more sophisticated arrangements, such as smuggling the money across borders in illegal transactions.

5.6 CONCLUSION

This thesis set out to establish whether or not poverty was a barrier to growth. In so doing, the analysis focused on the saving trap — one of a number of types of poverty traps that can afflict a poor country. There is some evidence that insufficient saving as a result of low income is responsible for low rates of investment, although the same evidence demonstrates that the relationship as described between income, investment and saving is weakening over time as capital markets grow more open, and poorer countries become more financially sophisticated. This by itself does not mean that poverty is not a barrier to growth. The new model that was tested in this chapter treated everything other than the rate of investment as exogenous. Just as with the accumulation of physical capital, improvements in health come at a cost and, once again, poorer countries are the least able to meet this cost. Improved health outcomes also improve the incentives around human capital accumulation, which in turn can have positive impacts on institutional quality. Rates of investment in poorer countries may not be low because rates of saving are low, but it cannot be ruled out that rates of investment in poorer countries are low because these countries are too poor to afford good health and good institutional quality. This thesis shows that: the low-level equilibrium trap is not caused by low levels of saving alone; and that therefore, the

solution is not to simply extend aid in the form of monetary transfers or foreign investment, as the balance of evidence suggests that only part of these inflows will be retained as domestic investment.

5.7 APPENDIX TO CHAPTER 5

COUNTRIES

The following countries were excluded from the analysis in this chapter due to a lack of data: *Afghanistan, American Samoa, Andorra, Angola, Antigua and Barbuda, Armenia, Aruba, Azerbaijan, the Bahamas, Belarus, Bermuda, Bhutan, Bosnia and Herzegovina, Brunei Darussalam, Burkina Faso, Cambodia, Cape Verde, Cayman Islands, Channel Islands, Comoros, Cuba, Cyprus, Djibouti, Dominica, Equatorial Guinea, Eritrea, Ethiopia, Faeroe Islands, French Polynesia, the Gambia, Georgia, Greenland, Grenada, Guam, Guinea, Hong Kong (China), Iraq, Isle of Man, Kazakhstan, Kiribati, Democratic Republic of Korea, Kyrgyz Republic, Lao PDR, Lebanon, Lesotho, Liberia, Libya, Liechtenstein, Macao (China), Former Yugoslav Republic of Macedonia, Maldives, Marshall Islands, Mauritania, Mayotte, Federated States of Micronesia, Moldova, Monaco, Mongolia, Montenegro, Mozambique, Myanmar, Netherlands Antilles, New Caledonia, Nigeria, Northern Mariana Islands, Palau, Puerto Rico, Qatar, Samoa, San Marino, Sao Tome and Principe, Saudi Arabia, Senegal, Serbia, Serbia and Montenegro, Seychelles, Solomon Islands, Somalia, St. Kitts and Nevis, St. Lucia, St. Vincent and the Grenadines, Sudan, Suriname, Swaziland, Taiwan, Tajikistan, Timor-Leste, Tonga, Turkmenistan, Uzbekistan, Vanuatu, Vietnam, Virgin Islands (U.S.A.), West Bank and Gaza, Republic of Yemen.*

DATA

AFFORDABILITY

RATE OF SAVING (SRATE)

The rates of national and domestic saving are calculated in the same way as for the analysis in Chapter 3.

RECEIPT OF FOREIGN AID (AID_GNI)

Estimates of the receipt of aid (now called 'Net official development assistance received') as a proportion of GNI are taken from the World Development Indicators, where the definition given is: *Net official development assistance (ODA) consists of disbursements of loans made on concessional terms (net of repayments of principal) and grants by official agencies of the members of the Development Assistance Committee (DAC), by multilateral institutions, and by non-DAC countries to promote economic development and welfare in countries and territories in the DAC list of ODA recipients. It includes loans with a grant element of at least 25 percent (calculated at a rate of discount of 10 percent). Data are in current U.S. dollars* (The World Bank, 2009). There are no data for the OECD countries (other than Turkey) — observations for OECD countries have been set to zero.

AVAILABILITY

CAPITAL TO LABOUR RATIO (KPERLA)

The capital to labour ratio is derived by applying the Perpetual Inventory Method to the Penn World Tables, version 6.2 (Heston et al., 2006) and follows the methodology used by Caselli and Feyrer (2007). The investment series is calculated by multiplying Laspeyres real GDP per capita by the population by the investment share of real GDP. The stock of capital in the first year for which the investment series is available is set to:

$$K_0 = \frac{I_0}{(g+\delta)} \tag{5.2}$$

δ is the rate of depreciation, and takes the value of 6 %, while g is the average, geometric growth rate for investment between the first year it is available and 1970. For countries where the investment series does not begin prior to 1970, g is the average, geometric growth rate for the first five years of the investment series. Estimates of the capital stock for subsequent years are estimated as:

(5.3) $$K_{t+1} = K_t(1-\delta) + I_{t+1}$$

The capital to labour ratio is derived from this by dividing the capital stock by the population, and then dividing again by 1,000, so that coefficient estimates can be seen in the first two decimal places of the regression output.

PRICE OF CAPITAL GOODS RELATIVE TO CONSUMPTION GOODS (PRICE)

The price of capital goods relative to the price of final output is determined using data from the Penn World Tables, version 6.2 (Heston et al., 2006), where 'price' is set equal to ***pi*** divided by ***pc***.

LABOUR FORCE WITH NO FORMAL SCHOOLING (LU)

Estimates of the proportion of the labour force with no formal schooling are taken from the Barro and Lee dataset, and information on how the estimates are compiled can be found in the accompanying paper (Barro and Lee, 2000).

UNDER-FIVE MORTALITY RATE (MR5)

Estimates of the under-five mortality rate are taken from the World Development Indicators, where the definition given is: *Under-five mortality rate is the probability per 1,000 that a newborn baby will die before reaching age five, if subject to current age-specific mortality rates* (The World Bank, 2009).

PROPERTY RIGHTS AND LAW ENFORCEMENT (EFW_PR)

Estimates of property rights and law enforcement are taken from the Economic Freedom of the World, and incorporate measures of: judicial independence; impartial courts; protection of property rights; military interference in the rule of law and

political process; integrity of the legal system; legal enforcement of contracts; and regulatory restrictions on the sale of real property. More information on how these indexes are estimated can be found in the accompanying annual report (Gwartney et al., 2009).

ACCESS TO SOUND MONEY (EFW_ES)

Estimates of access to sound money are taken from the Economic Freedom of the World, and incorporate measures of: money growth; standard deviation of inflation; inflation (most recent year); and freedom to own foreign currency bank accounts. More information on how these indexes are estimated can be found in the accompanying annual report (Gwartney et al., 2009).

CAPITAL MOBILITY

OPENNESS (OPENC)

The measure of economic openness is taken from the Penn World Tables, version 6.2 (Heston et al., 2006), where it is defined as: *Exports plus Imports divided by GDP is the total trade as a percentage of GDP.*

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